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Individuals learn and retain material more effectively when they attend to those characteristics of the environment about which they are to acquire information. Traditionally gestural and situational attention devices have been used in classrooms in order to attract attention for specific information. It is possible however that much more subtle cues serve even more significantly; the teacher's intense interest in his subject matter or cues which members of a group give to each other may create favorable climates toward learning.

The student attempted to study psychophysical arousal patterns of leader and members of a group as measures of such subtle cues in relation to certain characteristics of attention and learning. The subjects were five graduate students who served as group leaders and twenty-five undergraduates. Six polygraphic recording machines were used which permit continuous measurements of 1) skin resistance, 2) heart rate, and 3) respiration.

Several implications can be drawn from the data; group members do not generally vary in the amount of random attention they pay to a lecture. They learn best in longer lectures, and seem to relax most in the last lecture. Although differences among leaders had some effects, it did not effect students' learning scores. Arousal patterns as defined, e.g. deviation from the subjects own records, actually hinder learning while a fairly restful state enhances learning. Since psychophysical measures were most widely affected by the lecture content, it would seem that delivery, timing and quality of lectures have probably been highly exaggerated. In the course of this study many peripheral projects were developed; psychophysical measures were useful in the study of group processes.

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Polygraphic Arousal Patterns Related to Attention and Learning in C

Cooperative Research Project No. 1308

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University of Utah

Salt Lake City, Utah

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1. Problem

Without question, individuals learn and retain material more effectively when they attend to those characteristics of the environment about which they are to acquire information. We know that the readiness to attend varies with materials and from individual to individual. Further, we know that a given individual's attention span fluctuates over time. It is axiomatic that in order to make any educative process most efficient, one has to understand both the student's readiness to absorb new material and the attention devices which are effective in directing and sustaining attention.

Traditionally, verbal (e.g., "Now listen to this"), gestural and situational (such as the hint of a test) attention devices have been widely used in classrooms as well as in personal communication in order to attract attention for specific information. It is possible, however, that much more subtle, and quite different, cues serve even more significantly as attention devices, e.g., such cues as the teacher gives to his student through his own intense interest in his subject matter, cues he communicates by being particularly attentive to select material, or subtle cues that members of a group give to each other, and which create favorable or unfavorable climates toward learning. If independent measures of such subtle cues could be found, a sizeable gain in understanding of the learning process would be registered. The present proposal describes an attempt to study and to define some of these measures. Psychophysical arousal patterns of leader and members of a group are to be assessed for their relationships to certain characteristics of attention and learning. If such independent psychophysi

arousal patterns are indeed systematically related to learning, useful tools to study the conditions under which learning can be enhanced are provided.

The present study will be concerned with simultaneous polygraphic recordings of group leaders and group members. Answers to the following specific questions will be sought:

(1) Will there be consistency in arousal patterns across the specified number of sessions of each group within group members? (Do group members respond alike in each session?)

(2) Will there be consistency in arousal patterns across group members within sessions? (Do group members vary from each other significantly?)

(3) Will there be consistency in arousal patterns between group members and leaders within sessions? (Do leaders differ from members?)

(4) Will there be consistency for leaders within sessions? (Does a leader differ from session to session?)

(5) Will there be consistency for leaders across groups? (Do leaders differ from group to group?)

Additionally, the following relationships will be investigated:

(1) Relationship of number of arousal patterns in group members and their learning score. (Does number of arousals give information on quality of learning?)

(2) Relationship of number of arousal patterns in leaders and learning score in group members. (Does leader's arousal enhance members'

learning?)

Furthermore, the data will be inspected for:

(1) Distribution (in time) of arousal patterns in time sequence. (Is arousal subject to attention span?)

(2) Change in number of arousal patterns in the succeedi session of each group. (Does arousal change as members become bet acquainted?)

(3) Change in number of arousal patterns in the leader i his successive lectures. (Does the leader's arousals change as he gets familiar with the lecture task?)

(4) Number of arousal patterns of lecture periods, test ods, and discussion periods. (Does any one of these periods favor arousal?)

These questions were selected in order to assess certain aspects of the interaction of group leader and group members in learning and attention processes, and to discover conditions under which learning and attention will be enhanced.

Few studies of psychophysical correlates of learning in groups have been published. Research with PGR and other such psyc physical devices had one of its peaks of interest more that twenty years ago and is summarized by Woodworth (1938). From these stud it became clear that PGR cannot be used as a measure of mental wor such, but that it appears to register only the instance when the "direction of mental activity" changes (Woodworth, p. 259), i.e., when the individual sees certain information as presenting him with a problem--and when he solves the problem. PGR appears to me

the shock of "encountering something for which one is not prepared." In a more recent study with psychophysical stimuli, Dykman (1959) and his co-workers studied among other questions the effect of emotional impact on certain psychophysical measures. One of their conclusions are of significance here: "Subjects tend to maintain their group position (over several tests) in the three systems studied" (PGR, heart rate, respiration).

Berlyne (1960) discusses the most recent researches on arousal determinants (including many Russian studies) and is concerned with perceptual and intellectual activities. He discusses stimulus selection, exploratory and ludic behavior and describes the most recently used psychophysical measures related to this. Lacey (1954) reports on several pertinent research papers where psychophysic measures are being used to evaluate learning and attitude change. Several measures discussed in this chapter were adopted for the presen study as will be discussed below.

II. Procedure

A. Subjects: 1. Five group leaders were selected, all of whom have had previous teaching experience. They were either 2nd or 3rd year graduate students in psychology at the University of Utah between the ages of 25-31.

2. Twenty-five male group members chosen from volunteers of a beginning undergraduate psychology class. From 92 volunteers, these 25 men were chosen for their predicted grade point average of approximately 2.6 - 3.0; for age of 19-21 and for

an interest score in sciences of 30-60 on the Lee-Thorpe test. The predicted grade point average is based on high school grades and test scores in English, mathematics, and science.

B. Apparatus:

Six polygraphic recording machines, Keeler Model 6303, were used. The machines permit continuous measurements of (1) skin resistance, (2) heart rate, and (3) respiration. Records in each of the three channels are made on a motor driven paper tape moving at a constant speed of six inches per minute.

The channel for measurement of skin resistance is essentially a modified Wheatstone Bridge circuit.

The circuit can be adjusted to permit recordings of skin resistance from 0 to 250,000 ohms. When the circuit is balanced with the skin resistance of a particular S, the recording pin is centered on the paper tape. The S's resistance may then be read from a dial (calibrated in 5,000 ohm units). Changes in skin resistance are recorded by the up or down movement of the pin from the center of the tape. The amount of pin movement may be adjusted to maximum or minimum sensitivity. The sensitivity was calibrated so that one inch of pin movement was equal to 1,000 ohms. This calibration was maintained on all machines throughout the experiment. It should be noted that at this calibration the maximum change in skin resistance that could be recorded by pin movement was 10,000 ohms. The range of pin movement, from the top to the bottom of the tape is ten inches. Changes greater than 10,000 ohms require the circuit to be re-balanced to the changed

resistance.

Attachments to the S are made with a hand electrode. The electrode is placed in the palm of the hand with a spring around the back of the hand holding it in place. All Ss were required to wash their hands immediately before attachment. An electrode paste was used to improve contact.

The channel for measurement of blood pressure and heart rate is essentially a sphygmanometer. A rubber tube, which can be inflated, is wrapped around the S's arm. The tube is connected to a pressure gauge, and also, to a recording pin. The bag is inflated to a pressure between the Ss diastolic and systolic blood pressure. Within this range of pressure, changes in volume of the artery produce a corresponding change in the bag and also pin movements which record this change. Thus each phase of the heart cycle may be read from the tape. Continuous recordings of blood pressure cannot be made. The record gives a value somewhere between systolic and diastolic and records changes within this range.

In the experiment, the pressure in the cuff was maintained at the lowest possible pressure which would permit a recording of the heart cycle. This was to reduce the discomfort produced by the cuff.

Recordings of respiration are made by means of an expandable tube attached around the S's chest. The tube is attached to the recording pin by means of an air tight tube. Movements of the chest pneumograph produce an up or down movement of the recording pin. Thus

the pin movement parallel the entire respiration cycle.

It should be noted that in all three channels the recording pin is so constructed that the recording trace is an arc. When the rate of tape movement is used as a time referent, the different distance of the arc produces a time error, a special scoring key has to be devised to take care of this.

The six polygraphs were all operated in a room separate from the Ss. The seating arrangement was changed at the beginning of each experimental condition so that each S was attached to a different machine in each condition. The group leader was seated facing the five Ss. The machines were prepared by their operators to begin recording; when preparations were complete a signal, visible only to the group leader, was given to begin the lecture. A Wollensak tape recorder was used during each lecture.

C. Lectures and Scoring. Each lecture was constructed (by appropriate faculty members) for approximately 10 minute duration. The five lectures were concerned with (1) psychoanalytic theory; (2) testing; (3) learning; (4) psychophysiological (ear); and, (5) history of psychology. For each lecture a test of approximately 20 items was constructed, and the information pertaining to each item was marked on the lecture. Each lecture was then presented to a class of approximately 25 undergraduate students and a pre and post test was given. Items which appeared to be either too easy or unclear were then rewritten.

The pre- and post-test scores for each of the lectures are given in Table 1.

Table 1

Pre- and Post-Test Scores

Lecture	Mean Pre-Test	Mean Post-Test	Number of Ss
Ear	1	8.1	18
History	2.7	11.8	18
Learning	2.0	10	21
Testing	0.5	15	26
Psychoanalysis	6.2	14.3	21

The final lectures and tests can be inspected in Appendix 1. It should be noted that only one test had twenty multiple choice test items, while four tests had write-in tests items. These four tests were adopted because they minimized the chance expectancy on the test results and permitted a more certain designation of "improvement" of a particular test item. We kept the multiple choice test in the battery to gain some information on this particular point.

For the experimental groups, test scores were based on three separate measures. These are: (a) A learning score (L). An L score was given when a S showed post-test improvement on an item which he had missed on the pre-test. An item upon which the S was correct on the pre-test was not scored. The number of L items was then summed to give a total L score for each test. The intention in using the L score was to analyze learning which occurred as a direct consequence of listening to the lecture and which was independent of the Ss previous information. The L score could be related to the specific information in the lecture upon which the test item was

based. Thus the psychophysiological measures taken when specific information was presented could further be analyzed on the basis of the L score. (b) A Percentage score (P). Those Ss who had previous knowledge of the material were penalized as they statistically had less chance to show improvement (to obtain an L score). The P score was based on the percentage of possible L scores and allowed for this. (c) An achievement score (A). This score was simply the total number'correct' on the post-test.*

D. Arousal pattern:

1. Measures

Psychophysical measures taken from the three channels obtained by the polygraphic (cardiac, respiratory, GSR) were analyzed for the following specific scores.

1. Minimal Resistance: A single score representing the lowest actual skin resistance during the 10-second interval.

2. Number of Galvanic Skin Responses (GSR): This is defined as a sudden decrease in skin resistance of at least 125 ohms.

3. Magnitude of the GSR: The actual magnitude of the GSR in ohms in each 10-second period.

4. Heart Rate: The number of beats in a 10-second interval.

*The correlations between the different measures are:

	L	P	A
L	-		
P	.93	-	
A	.76	.77	-

5. Inspiration Fraction: The proportion of time spent in inspiration in the 10-second interval. Expressed as a percentage.

6. Magnitude of the largest inspiration in the 10-second interval.

7. Magnitude of the smallest inspiration in the 10-second interval.

8. Maximum distance between peaks of inspiration within a 10-second interval.

9. Minimum distance between peaks of inspiration within a 10-second interval.

2. Scoring

We wanted to discover (1) at which points of the S's psychophysical record deviation from his own record was noticeable (which time unit would deviate), and (2) to compute a Total Deviation Score for each S. In order to arrive at these values, we calculated all variances for all nine measures for each S and established a rank order for each of measures. By adding rank orders across for each S we could place all our Ss on a continuum rank order of variances. High variance was defined for our study as indicative of high lability (reactivity). In order to discover at which particular time a S would show reactivity, we calculated for each S mean and variance of each of the measures and marked the time units of the record which deviated. Approximately the extreme 10 percent of each measure was marked "D". (Heart rate: upper and lower 5 percent, respiration: upper and lower 5 percent, PGR upper 10 percent. The marked units were called "D Units". We were working

under the assumption that a given time unit (10 second) on a S record is deviating when one or more measures show indication of deviation from the respective distribution. Each D unit then had at least one, but possible two or three D's at a given 10 second interval. This is in line with the work of Lacey and others and this composite D score is probably a more plausible measure than any single score deviation.

Another "D" measure was obtained for some records by expert reading (a police lieutenant who worked in this area) to obtain some "intuitive" measures for a comparison with our more objective measures. Unfortunately, scoring of his intuitive findings proved an impossible task.

E. The Groups:

Each group consisted of five members and one group leader. Each group met for a total of five sessions, distributed over three weekends (less distraction in laboratory). The leaders and lecture material rotated as follows: each leader presented, once each of the five lectures prepared for him, each time to a different group, (see Appendix 2). Before and after each lecture the test was administered to the group members. Following the test the group members could discuss the testing situation with the workers. Polygraphic readings were taken throughout the lectures.

III Results

The results will be presented in three parts: (1) exploring various approaches to the analysis of the relationship of psychophysical measures with learning (2) psychophysical measures related to learning

in groups; (3) interaction of groups on the basis of D scores.

1. Exploring various approaches in the analysis of the relationship of psychophysical measures with learning. The first seven tables represent our efforts to discover a useful scoring system for the analysis of our data. While this information does not get directly at the question we had asked in this proposal, we wanted to take some sample readings to discover how valuable certain approaches might be.

Table 2

Comparison of Psychophysical Measures for Correct and Incorrect Items on the Psychoanalysis Lecture

Measure	Mean Correct Items	Mean Incorrect Items	t	p	Df
Minimal Resistance*	64,174	66,575	1.34	-	23
Inspiration Fraction**	33.1	32.5	.56	-	23
Maximum Inspiration	13.2	13.0	.64	-	23
Minimum Inspiration	10.1	10.1	.32	-	23
Maximum time between Peaks of Inspiration	9.19	9.05	.57	-	23
Minimum time between Peaks of Inspiration	8.22	8.37	1.23	-	23
Cardiac Rate***	13.01	13.15	1.18	-	23

*In absolute ohms of resistance

**Percentage of time in a 10-second interval spent in inspiration

***Number of beats in a 10-second interval

In this table the means calculated from all time units for each measure on all incorrect and correct items of the Psychoanalysis

lecture are compared. On this lecture the psychophysical measures do not differentiate correct from incorrect items. This finding, on the surface, appears to contradict findings in the literature. The finding may be due to the fact that our methods of exposing material differed from those ordinarily used. In many studies of this nature, a subject is asked to learn a specific item such as a nonsense syllable. His psychophysical alertness pattern is then evaluated on all the items he has learned vs. the items he has not learned. In our case the S listened to a whole lecture without being able to distinguish any specific items. During this experience he is in no position to judge where specifically he should pay attention. In comparing correct vs. incorrect items obtained in the 'whole lecture' approach, we simply obtained the infor ation that attention patterns during a whole lecture are about randomly distributed. An Alternate interpretation for our failure to discriminate between these items is possible which would confront us with the rather challenging question whether learning really has anything to do with attention? It might well be that if a person is exposed to a certain amount of information, he will just learn some of it irregardless of whether he makes an effort or not. Thinking about young children and their learning experiences this is a rather plausible hypothesis after all.

Table 3

Comparison of Psychophysical Measures
for Good and Poor Learners on the Psychoanalysis Lecture
Learning scores based on "L" scores

Measure	$\bar{X}$ Good Learners	$\bar{X}$ Poor Learners	t	p	df
Minimum Resistance	54,655	70,814	1.05	-	19
Inspiration Fraction	36.76	32.64	.84	-	19
Maximum Inspiration	14.44	12.85	.71	-	19
Minimum Inspiration	11.12	9.62	.82	-	19
Maximum Time between Inspiration Peaks	9.42	8.56	1.70	-	19
Minimum time between Inspiration Peaks	8.59	7.65	2.23	.05	19
Cardiac Rate	12.63	13.17	.95	-	19

Here we compared good and poor learners (upper and lower 40 percent) according to their "L" scores. Only a respiration measure proves to be significant in this analysis. The psychophysical patterns do not give us the information of who are the good or the poor learners, but perhaps for the fact, that the good learners breath a little more slowly. Of course, if this finding should be valid it may fill in some of the information as to what a good learner does.

Table 4

Differences between the means and variances of Skin Resistance, Inspiration Fraction, and Heart Rate for Good and Poor Learners comparison of A & L scores from all lectures.

	Based on "L" Scores					Based on "A" Scores				
Resistance	Good	Poor	t	p	df	Good	Poor	t	p	df
Mean	14.874	12.792*	.27	-	23	14.2269	13.4387	.01	-	23
6^2	34.4165	34.4821**	.15	-	23	34.1274	35.6050	.36	-	23
Inspiration Mean	161.94	163.77	.05	-	23	170.92	154.87	.51	-	23
6^2	250.33	344.67	.51	-	23	303.92	207.75	.49	-	23
Heart Rate Mean	68.41	63.72	.62	-	23	64.52	67.57	.35	-	23
6^2	3.51	4.03	.34	-	23	3.40	4.13	.47	-	23

*Resistance times 2,000

**Log Units

Here we compared absolute learning (L score) to learning plus achievement (A score). None of the three psychophysical measures, taken from the upper and lower (50/50 percent) learners differentiate these two groups. Apparently in our sample psychophysical differences were minimized by the fact that there were different lecturers and different lectures. At any rate, we were unable to make the overall statement that means and variance of psychophysical measures help us to identify good learners in all sessions, disregarding lecturer or lecture.

Table 5

Differences in the Percentage of Change for Correct and Incorrect Items in a Lecture on Psychoanalysis Measure (30-seconds before beginning of lecture)

Physiological Measure	Mean % of Correct Items	Mean % of Incorrect Items	t	p	df
Minimum Resistance	1.203	1.256	2.06	.05	23
Inspiration Fraction	.973	.961	.42	-	23
Maximum Inspiration	.954	.945	.71	-	23
Minimum Inspiration	1.012	1.015	.22	-	23
Maximum Time between Peaks of Inspiration	.997	.981	.74	-	23
Minimum Time between Peaks of Inspiration	1.027	1.013	.74	-	23
Cardiac Rate	1.029	1.026	.26	-	23

Our fifth table represents our attempt to check out the baseline hypothesis. Here we are using the percentage of change which occurs in each item as it is compared with baseline taken 30 seconds before the lecture was begun. Only minimum resistance appears to differentiate significantly the correct from incorrect items. The finding implies that a comparison of a S's baseline measures with his later measures is by and large not very productive, and that conductance is slightly increased with correct items.

Table 6

Comparisons of Percentage of Change of Psychophysical Measures for Good and Poor Learners on the Psychoanalysis Lecture Learning Scores based on "L" Scores

Measure	$\bar{x}$ Percentage Change for Good Learners	$\bar{x}$ Percentage Change for Poor Learners	t	p	df
Minimum Resistance	1.177	1.298	.92	-	19
Inspiration Fraction	1.030	.932	.85	-	19
Maximum Inspiration	.937	.932	.05	-	19
Minimum Inspiration	.996	.962	.71	-	19
Maximum Distance between Peaks of Inspirations	.945	.962	.38	-	19
Minimum Distance between Peaks of Inspiration	1.053	.966	1.13	-	19
Cardiac Rate	1.042	1.006	1.29	-	19

Here we divided the group into good and poor learners, (upper and lower 10 percent). We wanted to discover if good and poor learners differ in their psychophysical patterns. We discovered that in terms of percentage of change from a baseline good-poor learner did not differ significantly. Compared against baseline, good learner and poor learner performed equally well.

Table 7

Comparison of Weighted D-scores on the Psychoanalysis Lecture for Correct and Incorrect Items

	Correct Items	Incorrect Items	t	p	df
Mean Weighted D's	.163	.144	1.05	-	23

We made another attempt of using all correct and incorrect items

of the psychoanalysis lecture and assigned each time unit a weighted D score. This score was supposed to express to which extent the unit (on basis of all measures) deviated from the S's own record. All nine measures were used. A "D" was defined as a deviation within the distribution of this measure. Weighting was determined by the probability of the occurance of the deviating response in the specific distribution, (probability of occurence of 10 percent, would get a corresponding greater weight than the probability of occurance of 20 percent in a given period). Weighted Ds did not distinguish correct from incorrect items.

2. Psychophysical measures related to learning in groups.

In this part of results we are presenting our data on interactions between lecturers (called leaders here) lecture and group. The first table is on heart rate.

Table 8a

Analysis of Variance on Heart Rate $\bar{X}$s, Group/Lecture/Lecturer

	Sum of Square	df	Mean Square	F
GP	26.56	4	6.64	-
Ss/Gps	154.29	18	8.57	
Ord. Position	3.16	4	.79	-
Lecture	5.48	4	1.37	1.09
Leader	1.72	4	.43	-
Residual	109.22	86	1.27	
Total	300.43	120		

Table 8b

Heart Rate Group by Position/Leader/Lecturer

	Position	Leader		Lecture
I	323.2	1.327.1	P	327.2
II	330.7	2.332.5	L	333.4
III	334.0	3.328.0	H	328.1
IV	334.0	4.334.8	E	323.8
V	329.3	5.328.8	T	338.7

Table 9a

Analysis of Variance on Heart Rate Variability of Group/Lecture/Leader

	Sum of Square	df	Mean Square	F	
Groups	1.8476	4	.4619	1.18	
Ss/Gps	7.0489	18	.3916	-	
Position	.3238	4	.0809		
Lecture	4.0163	4	1.0041	2.92	< 05
Leader	1.3928	4	.3482	1.01	
Residual	29.5498	86	.3436		
Total	44.1772				

Table 9b

Heart Rate Variance by Position/Leader and Lecture

Position		Leader		Lecture		
I	19.33	1	23.91	P	15.29	(4)
II	18.93	2	16.49	L	19.65	(2)
III	20.24	3	18.35	H	26.63	(1)
IV	18.93	4	17.66	E	13.70	(5)
V	16.41	5	17.43	T	18.57	(3)

The tables indicate that there is no difference in most of the means or variances of heart rate. However there is a significant difference in the lecture term, which implies that heart rate variation is influenced by the specific lecture presented. From Table 8a it can be noted that largest variation occurred in the history lecture, second in the learning lecture, then testing lecture, psychoanalysis lecture and ear lecture. We shall later see if other measures correspond to these rankings.

Secondly we shall present tables on skin resistance.

Table 10a

Analysis of Variance on GSR Xs (min.res.) of Group/Leader/Lecturer

	Sum of Square	df	Mean Square	F	
Groups	45.388	4	11.347	1.787	
Ss/Gps	114.273	18	6.348		
Ord. Pos.	27.037	4	6.759	3.661	.01
Lectures	21.277	4	5.319	2.881	.05
Leader	18.475	4	4.619	2.502	.05
Residual	158.800	86	1.846		
Total	385.250	120			

Table 10b

GSR Group $\bar{X}$s by Position/Lecture/Leader

Position		Lecture		Leader	
I	80.026	P	85.185	1	60.200
II	83.557	L	61.591	2	66.466
III	62.556	H	57.974	3	84.633
IV	73.793	E	68.297	4	78.696
V	52.039	T	78.951	5	61.976

Table 11a

Analysis of Variance on GSR variables by Group/Lecture/Leader

	Sum of Square	df	Mean Square	F
Groups	7.3718	4	1.8429	-
Ss/Gps	40.9047	18	2.2724	-
Ord. Pos.	7.2124	4	1.8031	-
Lectures	1.6276	4	.4069	-
Leader	11.8354	4	2.9588	-
Residual	284.4931	86	3.3081	-
Total	353.4450			

Table 11b

GSR Group Variances by Position/Leader/Lecture

Position		Lecture		Leader	
I	179.3302	P	177.4551	1.	170.2869
II	169.5439	L	170.9895	2.	170.3390
III	167.5360	H	169.1230	3.	174.6757
IV	180.4680	E	171.7875	4.	176.7857
V	166.4157	T	173.9390	5.	171.9693

Inspecting the GSR data tables, no significant values appear on the variances, but significant values do appear on the means analysis of variance table, in the position, the lecture and leader terms. This is a very interesting finding, as we have now evidence that both, the specific lecture delivered and the person who delivers the lecture appears to determine conductance. Inspecting Table 11b

we find that mean resistance of lectures achieved the following order: Psychoanalysis, (most) testing, Ear, learning, and History. With regards to leaders the following order exists: 1 - 5, 2 - 3, 3 - 1, 4 - 2, 5 - 4.

With regard to position we now have evidence that Ss start out with high minimal resistance and end up with low minimal resistance. In other words, the order of presentation, disregarding of leader or content has a significant effect on conductance, Ss tend to get more involved (higher conductance) as the experiment proceeds. The order of position was I - 2, II - 1, III - 4, IV - 3, V - 5.

Thirdly we shall present tables on inspiration.

Table 12a

Analysis of Variance of Inspiration Fraction Means by Group/Lecture/Leader

	Sum of Square	df	Mean Square	F
Groups	461.01	4	115.25	-
Ss/Gps	2,433.99	18	135.22	-
Position	240.33	4	60.08	-
Lectures	131.24	4	32.81	-
Leaders	142.69	4	35.67	-
Residual	5,858.78	86	68.12	-
Total	9,268.04			

Table 12b

Inspiration Fraction Group Means by Position/Leader/Lecture

Position		Leaders		Lecture	
I	788.4	1	857.3	P	827.8
II	841.9	2	774.7	T	819.5
III	760.6	3	825.3	H	765.3
IV	843.0	4	808.8	E	830.5
V	843.9	5	811.7	T	834.7

Table 13a

Analysis of Variance of Inspiration Fraction Variability by Group/Lecture/Leader

	Sum of Square	df	Mean Square	F	
Groups	41,897	4	10,474	3.092	<.05
Ss/Gps	60,972	18	3,387	-	
Position	9,230	4	2,307	-	
Lecture	1,414	4	353		
Lecturers	5,559	4	1,390		
Residual	224,425	86	2,610		
Total	343,497	120			

Table 13b

Inspiration Fraction Group Variance by Position/Leader/Lecture

Position		Lecture		Lecturer	
I	1478	P	1359	1	1462
II	1878	L	1459	2	1233
III	1332	H	1606	3	1358
IV	1360	E	1501	4	1566
V	1288	T	1411	5	1717

Inspiration means are not significant but inspiration variance are, for the group term. In other words, groups do differ from each other in the inspiration fraction, which is apparently a characteristic of the specific individual of each group in disregard of influence of leader and lecture. Here we may have inadvertently found a specific, individual measure which does not easily yield to situational influence.

Next we are presenting various tables on learning scores and psychophysical measures.

Table 14a

Analysis of variance of all L score $\bar{X}$s by group/lecture/leaders

	Sum of Square	df	Mean Square	F	
Groups	7.77	4	1.94	-	
Ss/Gps.	257.66	(20-2)	15.48		
Ord. Position	36.75	4	9.19	2.02	
Lecture	76.58	4	19.14	4.21	< .01
Leaders	19.09	4	4.77	1.05	
Error	391.29	(88-2)	4.55		
Total	789.09	122			

Table 14b

L scores means by position/lecture/leader

	Leader		Lecture		Order
I	167.0	P	200.5	1	181.2
II	176.3	L	157.2	2	160.3
III	179.0	H	152.0	3	174.9
IV	158.8	E	166.6	4	158.0
V	189.3	T	194.7	5	196.0

We can learn from this analysis that different lectures are producing different 'L' scores, if leaders, position and group are taken out. Inspecting the 'L' Sum of means on Table 14b for different lectures we obtain the following ranking: Psychoanalysis (highest L); Testing; Ear; Learning; History.

Table 15a

Analysis of variance of all A score $\bar{X}$s by group/lecture/leader

	S	df	"A"	F	
Groups	26.30	4	6.58	-	
Ss/groups	190.93	(20-2)	10.61		
Ord. Position	71.61	4	17.90	3.87	$< .05$
Lectures	375.24	4	93.81	20.30	$< .01$
Leaders	21.88	4	5.47	1.18	
Residual	397.16	(88-2)	4.62		
Total	1083.12				

Table 15b

A score means by position/lecture/leader

Order	Position	Ord. Pos. Min. Res.	Lecture		Lecture Ord. Min. Res.	Leader	
I	249.6	2	P.	306.5	1	1.	217.2
II	209.3	5	H.	184.9	5	2.	236.6
III	250.4	1	L.	198.5	4	3.	239.8
IV	208.8	4	E.	219.4	3	4.	221.9
V	241.4	3	T.	250.2	2	5.	244.0

A further analysis of variance was performed on achievement scores. It was reasoned that perhaps achievement of a student may yield a different result than his pure learning score. We do find that the achievement score is significantly effected by both the lecture itself and to a lesser extent by the sequence in which the lecture was presented. (position). The ranking of these can be inspected in Table 15b. Position: I-2; II-5; III-1; IV-4; V-3, Lectures: Psychoanalysis, Testing, Ear, Learning, History.

Table 16a

Analysis of variance of total P scores means by lecture/leader/group

	Sum of Square	df	Mean Square	F	
Gps	546.29	4	136.57	-	
Ss/Gps	7,559.21	18	419.96		
Ord. Posit . .	1,034.60	4	271.15	2.40	
Lecture	3,987.09	4	996.77	8.84	< .01
Leader	554.47	4	138.62	1.23	
Residual	9,699.56	86	112.79		
Total	23,431.22	120			

Table 16b

P score means by position/ leader/ lecture

Position		Leaders		Lectures		
I	1240.6	1	1081.4	P	1423.9	1
II	1050.3	2	1162.6	H	1015.6	5
III	1193.7	3	1214.7	L	1102.2	4
IV	1038.0	4	1112.4	E	1116.6	3
V	1210.7	5	1212.2	T	1120.0	2

To repeat, P scores were based on the recognition that true learning scores were possibly distorting the picture a little, as not all Ss had an equal chance to get an equal number of L scores. These

Ss who had achieved a pre-test ± already knew the answer and would not be able to score as many "Ls" as the others. The P score was calculated by adjusting L scores to the chance each S actually had from the items left. Inspecting the tables we find that the lecture term is significant, apparently the lecture, with position, leader and group taken out influences the P score. The rank order, as taken from Table 16b is as follows: Psychoanalysis (high P) Testing; Ear; Learning; History.

In the next table we were computing the correlation coefficients for ranked variances with ranked "L" scores. With N 24 (23DF) 0.5=.404 and .01=515 are the significant correlations. The positive correlations show high reactivity related to high learning score. The only two significant coefficients are negative.

Table 17a

Correlation coefficient of L score and variance rankings for each lecture.

	Testing	Psychoanalysis	Ear	History	Learning
Minimum Resistance	-.01	-.14	+.04	+29	+07
Inspiration	+.04	+.29	-.40*	-17	+23
Heart Rate	-.03	-.09	+.07	-26	+05
Sum of 3	-.47*	-.05	-.11	-37	+26

Table 17b

Rank Order correlations of overall lability and overall "L", "P", and "A".

"L"	%	"A"
-07	-.16	-.12

Inspecting Table 17b which shows computation of overall lability based on summed ranks of the three channels, all three overall correlations are negative. In other words, we are permitted the hunch that Ss high on reactivity also score low on tests. The least reactive Ss learn best.

Table 18

Correlations between rank-lability from lecture to lecture .

	Ear	Learning	History	Psycho.	Testing
Ear	+	.36	.21	-.25	.28
Learning		+	-.02	.15	.11
History			+	-.28	.22
Psychoanalysis				+	.35
Testing					+

Table 18 gives us information whether a S is consistent from lecture to lecture in terms of his ranked reactivity on the three channels. None of the correlation coefficients are significant here. Apparently Ss do not perform very consistently in their reactivity from test to test situation.

In Appendix 3 we report means and variability (reactivity) for inspiration, resistance and heart rate data in terms of position. From this data we can rank all means and variances in terms of sequence. Rankings are for Inspiration $\bar{X}$: 4,1,3,2,5; Variance: 2,1,4,3,5; for Heart Rate $\bar{X}$,5,4,1,2,3; Variance 3,2,4,1,5; GSR $\bar{X}$ 2,1,4,3,5, and Variance 4,2,3,1,5.

3. Interaction of Groups on the basis of D scores.

Table 19

Analysis of Variance of "D" Units of 5 Groups of Subjects in each of 5 Equal Time Sections of 5 Lectures Presented by 5 Leaders

Source of Variation	Sums of Squares	df	Mean Square	F
Leader	0.012	4	0.003	3.000**
Group	0.000	4	0.000	0.000
Lecture	0.004	4	0.001	1.000
Subjects/within	0.010	9*	0.001	
Subjects	0.026	20*		
Sections	3687.61	4	2171.90	1.257
Section X Leader	1391.23	16	86.96	-
Section X Group	4022.73	16	251.30	-
Section X Lecture	4426.19	16	276.63	-
Pooled Residual	70432.79	44*	1600.75	
Total	88966.36	116*		

*Corrected because of missing subject in Group IV.
**Artifact

In the next table we are presenting an analysis of variance of the D units, projected over 5 time sequences, of all Ss. Here we were re-scoring all records in terms of deviation from the S's own record per time unit. The D unit was arrived differently from our earlier exploratory effort. To repeat shortly: The GSR was computed for each time unit for each S. The upper 10 percent of conductance scores, approximately both upper and lower five percent of inspiration fraction

and approximately the same for heart rate were computed as D units. In this analysis we called "D" any time unit which was deviating, disregarding whether one or two or three deviations contributed. We did not weigh the amount of deviation in each unit, as we reasoned here that a Ss may show up in any of the three channels as deviating, and that deviation in all channels is not any more significant than deviating in one channel. After determining a D record for each S we then divided each S's record into five sections, each section consisting of 20 percent of the total number of time units, so that we could assess the S's D distribution over his whole record. The analysis of variance presented in Table 18 shows the congruence of the various curves, presented visually in Appendix 4. None of the terms are significant. In other words, arousal pattern (D units) are randomly distributed and not influenced by lecture, leader, or group.

Table 20

Comparisons of Rankings of lectures on Significant Psychophysical Measures, Learning Scores and time of reading lectures.

Rank Order	H.R.G.	Min. Re $\bar{X}$	L	A	P	Time
1	H	H	H	H	H	L
2	L	L	L	L	L	H
3	T	E	E	E	E	E
4	P	T	T	T	T	P
5	E (Low P)	P (High)	P(High)	D(High)	P(High)	T (Longest)

In our next table we present the ranking of lectures from any of the various analysis of variances where the lecture term had been significant,

It becomes apparent that the three learning scores, "L", "A", "P" show full agreement in the ranking. More surprising is the finding that Min. Resistance also shows total ranking agreement with these learning scores. In terms of this analysis our data suggests again (as have our exploratory studies) that S who are least reactive appear to learn most. With regards to heart rate variance there is a rank order correlation coefficient of .70, which implies that the S with low heart rate variation learns somewhat more effectively. Each lecture was read by all five leaders, but each lecture did take a different total sum of times to read. We note that the longest lectures relate to learning and Min. Resistance to the extent of .80, implying that the longer the lecture the less reactivity and the more learning occurred. See appendix 5 for table on time.

Table 21

Position Rankings of Various Psychophysical and Learning Measures.

Lectures	Insp. $\bar{X}$	σ	HR $\bar{X}$	σ	Max.Res. $\bar{X}$	σ	Min.Res. $\bar{X}$	A
I	4	2	5	3	2	4	2	2
II	1	1	4	2	1	2	1	5
III	3	4	1	4	4	3	4	1
IV	2	3	2	1	3	1	3	4
V	5	5	3	5	5	5	5	3

Finally our last table shows an overall ranking of scores of Psychophysical measures on all three channels. We note that Inspiration Variance, Maximum Resistance $\bar{X}$ and Minimum Resistance $\bar{X}$ have similar

ranking, an occurance which will happen only one in 120 times by chance. That minimum and maximum resistance $\bar{X}$ rank alike is not too surprising, but that resistance $\bar{X}$s are correlating with inspiration variance bears further investigation. Perhaps the effect of variability in breathing is more closely related to conductance--over a given time sequence-- than has been thought. On inspection none of the position rankings appear to be obviously related to the learning (A) score. Apparently time sequence and position of lecture do not effect both variables alike. But we may do well to note the curious fact that six out of eight columns end up with the figure '5'. Since our Ss knew that the fifth lecture was their last one, this suggests that in this last lecture the Ss relaxed in inspiration mean and variance, HR variability, Maximum Resistance $\bar{\bar{X}}$ and σ and Minimum Resistance $\bar{X}$. Perhaps we obtain from these measures incidental support that our psychophysical measures indeed represent some behavior such as stress or tension.

IV Conclusions and Implications:

In the following we shall present some of our original questions and attempt to answer these from our data.

(1) Do group members respond psychophysically alike in each session? Do they vary from each other? Do leaders differ from members? and do leaders differ from session to session, from group to group?

Group members do not generally vary in the amount of random attention they pay to a lecture. These attention states as measured

by psychophysical indicators appear to be randomly distributed throughout the lectures, and seem to have little relationship to subject matter, or group leader, or learning itself. But individuals do differ in the time they take for inspiration. This apparently is a very individual matter not effected by position or sequence of a lecture, the lecture itself or the leader. Good learners appeared to breathe more slowly, and they appear to learn most in psychophysical states where they are least reactive. They also learn better those lectures which are longer, though there is only a small relationship of learning and reading speed of lecturer within each particular lecture. The group members do not respond psychophysically alike in all sessions, the sequence of sessions is significant, (though this influence does not give us any clear direction) and all group members appear to relax most in the last session. They appear to respond to different lectures differently both psychophysically and in the actual learning they do. In other words, it would be possible to obtain psychophysical measures on a group and predict learning in a given learning situation, with such measures as long as the specific reactions of similar learning situations have been studied. The group members who learn most have apparently a measurable lower rate of heartbeat variability and lower GSR conductance. The lectures in which our Ss learned most were the clinical lectures, psychoanalysis and testing--even though it is not entirely clear why. These lectures were comparatively the longest or maybe the other lectures were seen by our Ss as being a little further removed from their interests, and they felt that it took more of an effort to

recall them.

Leaders differed from other Ss in that no reliable measure of their psychophysical record could be analyzed reliably due to their reading the lecture. We got nevertheless a good estimate of the effect of the leaders on the groups essentially through the statistical design used (Analysis of Variance Latin Square). Difference among leaders had some effects. The most significant effect different leaders had on their Ss was in two measures: GSR Minimum Resistance $\overline{X}$s and Heart Rate Variance. That means that differences among readers effected conductance and heart rate variability of Ss, but it did not effect their learning score or other psychophysical measures. Even though each of the leaders differed markedly in the time it took to read the standard lecture there was very little relationship of reading speed to learning within each lecture. We cannot answer the question if leaders differ from members in their psychophysical patterns but can say that leader differences are significant to the extent that each leader appears to produce with the two measures indicated a situation rather specific to him, his psychophysiological "fingerprint" on the group as it were.

(2) Does arousal pattern give information on quality of learning? Is arousal subject to attention span? Does arousal change as members become better acquainted?

We can state that arousal patterns as we defined them i.e. as deviation from the S's own records, does not only enhance learning but actually hinders it. Our findings suggests that the organism should be at a fairly restful state to enhance learning, (slow heartbeat and

breathing, low conductance), which is quite different from the alert state which has been proposed on enhancing learning. But as stated perhaps our method of testing lectures instead of specific stimuli may explain the differences.

Psychophysical deviations from the S's records were randomly distributed throughout the lectures, and our laborious analysis of D distribution came to naught. Apparently in the time we engaged our subjects, attention states differed but did not relate to learning or achievement. Psychophysical measures in our study were most widely effected by the lecture itself. It was read slow and it was read fast, by different lecturer and at different times in sequence, but the lecture term showed up significant throughout many of the analysis. Our Ss learned more from some lectures than from others and they responded differently psychophysically to different lectures, and we obtained here yet another evidence of the significance of programing information properly for effective learning. The psychophysical "fingerprint" which each sequence of words has on the learner may be thought of as an important consideration in the learning process.

(3) What broad significance did our study have? Our data suggests that more emphasis must be placed on the lecture itself than on the way it was delivered or even on who delivered it. Apparently certain questions of a given lecture, the specific nature of which we do not know as yet, will enhance learning. Our work suggested to us that the more peripheral cues of group interaction such as can be measured with our instruments are not very important in effective learning. A good

delivery, or an appropriate timing or the sequence in which the lecture is delivered and even the quality of the lecturer himself (provided he presents all the essential elements of the lecture) is probably only of slight significance in learning and has been probably highly exaggerated in recent history.

We also learned that the organism of the S is of some significance in his learning ability, in that a state of rest (as defined above) seems to enhance learning and a psychophysical deviation from this normal state seems to detract from the learning ability of a S. We also learned that the psychophysical reactivity of an individual does not appear to effect reactivity of another individual at least not in the type of setting we studied.

Finally we learned much about our psychophysical measures (we still wonder about the relationship we discovered of inspiration-fraction with conductance) and their usefulness and limitations. We learned that such measures as inspiration fraction and conductance would be applicable to many other problems and we developed several peripheral projects, on concept formation problems, creativity, and adjustment measures. We became particularly interested in the inadequate measure of 'learning' we used, and began to search for better measures, such as would not identify learning so exclusively in terms of memory. We are presently also exploring more useful ways of scoring psychophysical indices and are on the tract of an adaptation measure, which will be discussed elsewhere. Altogether we are encouraged in the belief that psychophysical measures are in fact useful in the study group processes.

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APPENDICES

APPENDIX I

LECTURES AND TESTS

A SHORT HISTORY OF PSYCHOLOGY

Psychology today is respected for being a science. Sometimes this field is included within the biological sciences; sometimes within the social sciences. Both inclusions are undoubtedly correct since contemporary psychology is usually defined as the scientific study of the behavior of the human being as he reacts and adapts to the many forces that arouse him to such activity or conduct. One would need to include social forces as well as the direct physical forces of his environment when attempting to account for the causes which impel human reaction at almost any given time of his life. In fact, our human being may be looked upon as being a very complex bio-social organism.

A rational approach to human nature and its problems may be found in the great philosophies of ancient Greece and Rome. A sort of psychology can be found in the teachings of Democritus, Socrates, Plato, and Aristotle in the four centuries preceding the birth of Christ. Aristotle even discussed man's five major senses, and assembled for the first time certain laws of learning as he described how and why certain ideas were associated together and remembered. Emotions, or the "passions," were considered as base, and in the search for the best way of life,reason was elevated to an ideal state.

One serious weakness appeared in this early rational philosophy, and it required many centuries of intellectual progress before the error could be brought under control. Man may reason, and thus escape

the pitfalls of disorganized emotional conduct. But the result of his reasoning can be no better than the facts he employed as he reasoned out an answer. Knowledge must be acquired first, and it wasn't until after the Dark Ages that inventions, discoveries and the spirit of inquiry led to the accumulation of these needed facts. Scientific knowledge then began to accumulate.

Psychology, as a science, did not actually come into being until the middle of the nineteenth century. Wilhelm Wundt, using the methods and many of the materials already established by physicists, physiologists and mathematicians attempted to bring the mind, or consciousness, into the laboratory, and, under controlled conditions, then reduce it to its simplest components. Subjects were to introspect, and then report just what appeared as simple, elementary mental states. This first school of psychology was known as Structuralism, since it attempted, using scienfific methods, to discover and describe the elemental structures of the mind.

Others within this new science of psychology were not content merely to describe the characteristics of so-called mental elements. Their work, also of a careful scientific nature, was directed to the larger and more complex mental processes, such as memory, habit formation, feelings and the intellect. This period or system of psychological development was known as Functionalism. Almost all late nineteenth century and early twentieth century American psychologists would be included here. Such great names as William James, John Dewey, G. Stanley Hall, and E. L. Thorndike marked this early, golden era of

American psychology. These psychologists were interested in mental functions and performances when adults, and children, were placed in problem solving situations.

Psychology received another strong assist from biology, especially that which emerged from the works of Darwin and Galton. Hereditary influences were respected, and the early years of a child were now seen to be of very real importance in any effort to understand the behavior and conduct of the adult. Sigmund Freud used this concept as an underlying theme for what he called Psychoanalysis. While some of Freud's views are not so readily accepted today, his tireless work in this field did emphasize that many aspects of human behavior can only be understood when hidden motives, wishes, desires and the past echoes of early frustrations are included in the total picture. There are in each person's make-up forces which are unseen, as well as the outward behavior which can be seen and measured. The psychologist must respect these hidden forces in his studies.

Another later movement, known as Behaviorism, discounted the traditional belief that it was necessary to assume mental processes as being different from bodily or physiological processes in general. In fact, John B. Watson in 1919 stated that psychology could give up the terms "mind" and "mental" without any loss of material or effort. Such terms, said the Behaviorist, were relics from ancient mysticism and philosophical speculation, and that all human behavior and conduct could be explained and measured by viewing it as the reactions of a complex living organism responding to natural stimuli. While many a

traditional psychologist of the 1920's opposed this behavioral approach, by 1935 it was commonly accepted as the corner stone upon which a truly scientific study of human nature and conduct could be erected. Even thinking or thought which earlier had seemed to be the very essence of mind stuff, was now being observed as being mainly made up of silent speech patterns.

One of the most recent developments in psychology is referred to as Gestalt Psychology. The term, Gestalt, is a German noun best translated as referring to a totality or configuration, rather than to small units or parts. Max Wortheimer, Wolfgang Kohler and Kurt Kofka were pioneer names in this movement, and although many others, such as Kurt Lewin, deserved to be included. Actually Gestalt psychology is more of an extended way of looking at psychological problems than being a separate school or system. The statement that "the whole is more than the sum of its parts" stems from Gestalt psychology, and asks that human behavior be observed and measured in its totality rather than conveniently broken up into bits or parts. This is referred to as a molar rather than a molecular approach to the understanding of human nature; that it is not enough to study isolated reflexes or small parts of human conduct. One must observe the total individual as reacting to a total situation. The complete pattern of both must be examined.

HISTORY OF PSYCHOLOGY

Considering the two major forces acting on the human being, one can best describe him as a (1)_____ organism.

Aristotle assembled for the first time certain laws of (2)_____ discussed the (3)_____ and elevated (4)_____ to an ideal state. The serious weakness of this early rational philosophy was that (5)_____and_____ are necessary for science.

The first school of psychology was known as (6)_____ sponsored by (7)_____ and it detected and classified elementary mental states through the method of (8)_____.

The next period of psychological inquiry was concerned with more complex mental processes such as (9)_____,_____, _____, This system was known as (10)_____. The two names of this age are (11)_____,_____ and it could be dated to the (12)_____.

Freud integrated into his theory the (13)_____ influences of man and with it emphasized the (14)_____ of man.

A later movement (15)_____ as led by (16)_____ threw out such terms as "mind" and "mental", and psychology was viewed as the study of an organizm in its response to (17)_____, a system which essentially is still being explored. This movement was followed by a development called (18)_____ psychology, identified with such a name as (19)_____which is

concerned with a way of looking at psychological problems by measuring (20)_____ rather than (21)_____. The approach has been called a (22)_____ approach to the understanding of human nature.

LECTURE ON THE EAR

All organisms are sensitive to their environments, but mere sensitivity is not enough for any but the most primitive of animals in any but the most stable of environments. Higher organisms must discriminate different environments and differences within their immediate environments. This requirement is met by the various sensory systems whereby animals find food, shelter, mates, and safety. Each animal has sensory organs which are, in many instances the ultimate in sensitivity and discriminatory power.

The ear is one such organ. Its realm of sensitivity is vibration, and it is an ideal instrument for an animal submerged in an elastic medium like air. Nearly any environmental event, any release of energy, sets the air addancing, and the near perfect elasticity of the air carries word of this event in all directions. The ear constantly "scans" the world, disregarding the commonplace, hearing the novel, alterting to potential danger. It is no accident that sharp sounds are natively and universally the most effective stimuli to the startle reflex.

Like the eye, the ear is a distance receptor; it responds to sound sources at a distance. Indeed, sounds are rarely heard <u>at</u> the ears; they are heard outside the body, localized in the environment. When a truck rumbles the ground, we feel vibration in our legs, but we never hear the rumble <u>in</u> our ears. Always the sound is "out there." This localization is especially a function of the two ears working together. The sound is heard as originating toward the side of the

additional distance the sound wave must travel to reach the farther ear means that the ears will be stimulated in succession and at different intensities. The time difference may be as little as 3/100,000ths of a second and still be effective in permitting correct localization. Further, because the speed of sound is a constant 344 meters per second in air, this time difference is largely dependent upon the angle between the head and the sound source. The greater the time difference, up to about two-thirds of a millisecond, the more nearly at right angle to the head is the sound.

The human ear is sensitive to vibration frequencies from 20 cycles per second to about 20 thousand. The low frequencies are heard as bass notes and the high frequencies as treble. However, sensitivity is far from uniform throughout the scale. Three octaves above middle C, the ear is 10 thousand times more sensitive than it is two octaves below. In its most sensitive range, the ear responds to sounds so faint they move the eardrum a distance of only half the diameter of a molecule of hydrogen--hydrogen, the smallest bit of natural matter on earth. This amount of energy is so small one would have to multiply it 300 thousand times to break the surface tension of water. If our ears were any more sensitive, we would hear the random movement of warm air, and sunlight would have our ears ringing perpetually.

But this ability to detect signals of fantasticly low energies is only part of the story. The range of intensities over which the ear discriminates is equally extravagant. To illustrate the extent of this range, let's consider a hi-fi record player. A good hi-fi

system has an intensity range of about 10 thousand-fold; that is, with the volume control unchanged, the instrument plays a crescendo at about 10 thousand times the intensity at which it plays the softest pianissimo. The intensity range of the ear is 10 million million--the equivalent of 1 billion hi-fis end-to-end.

Sound intensities are measured in terms of the amount of energy they contain; that is, in terms of the amount of force they exert against any surface they strike. This measurement may be done most accurately with a Rayleigh disc, or more conveniently with a calibrated microphone. The most common manner of measurement, however, is simply to determine the power in watts being used to drive the loudspeaker. For this, first one measures the wattage necessary to produce a just audible intensity and then the wattage at the intensity which is being measured. The ratio of these two wattages gives the intensity of the sound which can just barely be heard under the particular conditions of the measurement. This ratio of intensities is always expressed in decibels. The great advantage of this ratio-of-wattages method is its simplicity and its automatic allowance for any peculiar circumstances which may affect audibility at the time of the measurement.

In common parlance, the intensity of a sound is its loudness. Strictly speaking, however, intensity is a physical characteristic of the sound stimulus, whereas loudness is a psychological response to both intensity and frequency. If we take a tone of a given frequency, say,

tone of a given intensity, say, 40 decibels, and increase its frequency, we may find loudness increasing, or decreasing, or doing first one and then the other. At the given intensity, a tone of very low frequency will be inaudible--loudness will be zero. If we then start to increase the frequency, we will find that the tone will become audible, then wax moderately loud. But with a further increase in frequency, the tone will fade and again become inaudible. At our given intensity, we will have passed through the frequency spectrum from sub-sonics, through the audible range, and then on to ultra-sonics, and loudness will have come and gone.

Sounds may be very different and yet be of the same loudness. A cough, a spoken word, a trumpet call, and the wail of a siren can all be equally loud. The unit of loudness is called the sone, and as a unit of loudness, the sone is analogous to the gram as a unit of weight or to the centimeter as a unit of length. Two sones is twice as loud as one; ten sones is five times as loud as two; and a 500 sone blast from a tuba is just as loud as a 500 sone sonic boom. This equivalence means that the auditory system, the ear and the nervous system central to it, converts the intensive aspect of all sounds to a common attribute. And even more remarkable, each ear makes this conversion separately--the same sound in two ears is twice as loud as in either ear alone.

THE EAR

Animals used their (1)_____ systems to (2)_____ their different environments.

The ear is sensitive to (3)_____ and this is idealy suited to a (4)_____ like air. Sharp sounds are the most effective stimulis to the (5)_____.

Both ear and eye are (6)_____ receptors. Localization of sound works in a manner whereby the sound is heard originating (7)_____.

The difference in stimulation may be as little as (8)_____ of a second.

The human ear is sensitive to vibration frequencies from (9)_____ to _____ cycles per second. Sensitivity of the ear is not (10)_____ throughout the scale.

In the five octaves around middle C, the sensitivity of the ear differs by as much as (11)_____times. If ear would be more sensitive, we would have the problem of (12)_____.

The ear not only responds to very low energy but also responds over an enormous range in (13)_____. The range is about (14)_____ fold.

There are three ways of measuring the energy contained in sound. They are (15)_____, (16)_____, or more commonly (17)_____. This latter measure is expressed in decibels and is usually measured relative to the intensity of the sound which (18)_____.

In common parlance the intensity of a sound is its loudness but strictly speaking this is an error, as loudness is a (19)_____.

An increase in frequency with intensity remaining the same (20) will/___/ will not/___/ affect the loudness.

The unit of measurement in loudness is a (21)_____. The ear converts the intensive aspect of all sound to this common attribute and with two ears this conversion is (22)_____ as loud.

LECTURE NOTES ON PSYCHOANALYSIS AND RELATED AREAS

13. One of Greud's most important contributions which relates to the sexual instinct is that the sex instinct is displaceable. This means that pleasure derived from sexual sources can be found in behaviors other than sexual. For example, in sublimation Freud can still speak of a gratification of the sexual instinct which in this case is displaced to cultural and artistic activity.

23. The model which Freud followed and on which he built his well known "pleasure principle" is the model of tension reduction. According to this model, pleasure does not occur when the equilibrium is disturbed by the individual seeking certain types of gratification. The pleasure is only occuring upon the organisms return of a state of equilibrium.

25. Many people have speculated of the philosopher closest to Freud. Freud himself told us that he was perhaps closest to Shopenhauer, in fact, so close that he never wanted to read him. The closeness is due to the fact that both evolved a model of a state of equilibrium whereby the disturbance of the equilibrium is called "unpleasant."

45 Freud defined symptoms as behaviors which would 'bind' anxiety into certain activities. This model is a useful one in that it recognizes anxiety as a source of many behaviors, even though the behaviors cannot be directly described as "anxious."

51. Unfortunately we have not yet a good experimental test of repression. Repression is after all a very specific kind of forgetting which not only occurs automatically but also leaves a significant residue in the unconscious. Most present experiments have been done on differential forgetting but have left out the residue which is part and partial of Freud's theory.

56. Sullivan, the American psychiatrist maintains that anxiety is a result of the infant's feeling of a loss of euphroia or security, contrary to Freud who felt that anxiety comes from certain fears.

43. Much has been written about the psychological genesis of schizophrenics. Many have argued genetic factors. Some have argued sexual factors, but Hunt believes essentially that it is a motivational factor, the motivation to socialize shows deficit.

55. Many individuals have argued that a psychoanalysis takes too many years. Alexander has proposed definite dynamic mechanisms to reduce the length of time. Rank tried to solve the same problem by setting the time limit to treatment. None of these points have as yet been established as valid.

63. Freud believed that each state of psychosexual development has a characteristic consequence. A particular fixation during the oral phase might become associated with passivity in an individual in later life because a child learns that gratifications are carried to him. The anal state is one in which the child first learns to deal with control and property. Certain fixations at this state for example might result in greediness and the wish to collect things. Each of the psychosexual phases have their specific outcome.

67. The preferred erogenous zones of the body are those which contain mucus membrane. Freud stated however, no part of the body is exempt from libidinal cathexis and consequently there is at least a possibility for all parts of the body becoming erogenous zones.

71. Spitz's research, although much criticized with regards to its validity, gives the idea that marasmus in young children is due to the fact that they obtained a minimum of stimulation. He believed that it occured most frequently when mothers would be absent from their child in the very critical months between the 6th and 18th month of life.

62. Originally Freud believed that the sexual instinct was the source of most behaviors that were not falling under the category of self preservation. After the World War Freud observed that individuals are trying to repeat the events which previously had frustrated them. He reasoned that some mental conflicts are apparently due to the ego's attempt to cope with previously unsuccessful behaviors.

57. In 1926 Freud made a major change in his theoretical model of repression. While previously he believed that a person repressing thought processes becomes anxious because of repression, he later formulated that quite contrary anxiety is the cause of repression. This reversal had significant consequences as it gave again more control to the ego.

58. Adler who is one of the disciples of Freud who later broke with him, postulated that one of the basic drives of men's behavior is to come to grips with his inferiority feeling. Inferiority feelings force man to compensate in the very area of inferiority. An example would be a stutterer learning how to speak publicly. To understand a person's behavior then, one would have to look at his methods of compensation.

72. One of the interesting mechanisms Freud had to deal with was the specific fears individuals develop, such as fear of the dark, fear of closed places, etc. Freud believed that phobic reactions were symptoms of a more generalized anxiety. Anxiety apparently can be changed into a specific fear in the phobic reaction.

11. Freud believed that during the oral phase specific types of mechanism would develop. The oral phase is closely related to incorporation and identification. These mechanisms will determine to some extent the future development of the person.

14. Narcissism is defined as a state where the own body becomes the libido or love object of the child. Some people maintain a narcissistic adjustment throughout life but others are able to invest their libido in others than in themselves.

19. The child goes through the oral phase in which he learns either to wait for or work for gratifications. Then he goes into the anal state in which he learns to deal with internal and external controls. Then comes the phallic state where he will essentially deal with the psychosexual relations with his parents in the so called "oedipal" conflict; later he goes through the latency stage where he will be temporarily freed from the psychosexual conflicts. All these stages are important in formulating his personality.

20. Jung believed that certain genetic contributions to our personality can be identified. He believed that we have a racial heritage from all the generations before us. Jung supports his assumption by referring to universal symbols which seem to occur everywhere disregardless of culture. The theory has been much criticized because of its vagueness.

24. Rogers nondirective theory of psychotherapy has some closeness to Rank's theory but is quite different from those of Jung and Freud. The essential difference between the theories comes from the role phenomenology plays in their models.

PSYCHOANALYSIS

1. According to Freud, an important consideration of the sexual instinct is that the sexual instinct is: (1) displaceable, (2) objectless, (3) basic cause for egocentrism, (4) not always of equal strength.

2. The "pleasure principle" is (1) libido principle, (2) reality principle, (3) Cathexis, (4) Tension Reduction, (5) pleasure, if one lives by principles.

3. Philosophically, Freud is closest to (1) Kirkegaard, (2) Shopenhauer (3) Nietche (4) Krafft-Ebing.

4. According to p.a. theory symptoms are (1) orginating in the id, (2) based on castration fear (3) really dream symbols (4) binding anxiety.

5. Repression has been investigated experimentally most often in demonstrations of (1) recollections of the pleasant (2) affective associations (3) differential forgetting (4) retroactive inhibition.

6. Anxiety is a result of an infant's feeling of loss of "euphoria" or security is suggested by (1) Sullivan (2) Adler (3) Reich (4) Rank.

7. Hunt argues that psychological deficit in schizophrenics is due to the (1) motivation factor (2) sexual factor (3) genetic factor (4) dynamic factor.

8. Instituted the setting of a definite time limit to treatment: (1) Freud (2) Alexander (3) Rank (4) Ferenczi.

9. Traits of greediness and collecting most reflects what state. (1)oral, (2) anal (3) phallic (4) latent.

10. In the course of development the following part of the body may become an erogenous zone: (1) the wrist (2) the foot (3) either of these, (4) both of these.

11. Present indications are that marasmus is due to (1) inappropriate feeding (2) sudden weaning (3) lack of stimulation (4) basic biological defect.

12. From his observation after the World War, Freud reasoned that mental conflicts are not only sexual in origin but may be due to coping behavior of the: (1) instincts, (2) ego (3) birth trauma (4) sexual aberrations.

13. Anxiety has been viewed by the later Freud as (1) repressed libidinal energy, (2) the cause for repression (3) cause for ideations (4) a very bad thing.

14. The concept of "inferiority feelings" is best associated with (1)Rank, (2) Adler, (3) Jung (4) Fromm.

15. Anxiety is changed into specific fear in (1) phobic reactions (2) reaction formations (3) conversion reactions (4) obsessive compulsion reactions.

16. Of the following behavior mechanisms which is related to the oral period? (1) fixation,(2) regression, (3) identification,(4)repression.

17. Developmentally narcissims is following by (1) ego libido, (2) investment in others (3) latency period.

18. The beginnings of the oedipal conflict correspond closely to the onset of the (1) oral (2) anal (3) phallic (4) latency stage of psychosexual development.

19. That part of the unconscious which is attributed to our racial heritage is finding expression in (1)the pre-conscious (2) the subconscious (3) universal symbols (4) dreams.

20. Which member of the analytic family is closest to Roger's theories? (1) Freud (2) Fenichel, (3) Jung, (4) Rank, (5) Horney.

TESTING

Everyone who has been to school knows something about tests. Almost all children who go to American schools have had personal experience with a psychological test designed to measure not only their achievement or progress but also their ability to learn. In this talk, we shall be concerned primarily with the latter, that is, measures of a child's ability to profit from the kinds of experience afforded in the average school. They are popularly known as Intelligence or I.Q. Tests. These tests are also called measures of general ability to distinguish them from those that assess achievement in special areas such as history or social studies or mathematics, or even of others that are designed to give a picture of a person's personality. There are thus three kinds of tests, general mental ability, achievement, and personality.

Of the three kinds of tests most widely used in schools, clinics, the Armed Forces, and in business and industry, those of general mental ability are a source of some pride to modern psychology. It has been said that, "The outstanding success of scientific measurement of individual differences in behavior has been that of the general mental test" The Stanford-Binet Test of Intelligence is a good example and stands as the most important single contribution of psychology to the practical guidance of human affairs.

In what follows, I would like to give you a brief historical sketch of tests, show something of the growth of the testing movement in the Western world, and then describe the essential features of a test, those characteristics that make test scores meaningful and significant.

In the history of tests, Sir Francis Galton contributed in an important way to their development. Apart from his major interest in the heredity of men of genius, he also devised many useful ways to show individual differences in behavior. It was later in 1905 however, that the first successful general mental test was created by Alfred Binet. He had worked with and observed children for more than 10 years before this time. When the opportunity came, he created a scale designed to distinguish dull from average and bright children. His purpose was to design a test which would help teachers and others to select out those children who could not profit from normal school experience. Even his first attempt was remarkably successful. Since then, many improvements have been made, culminating in the most recent revision, that of 1960. Then as now, the chief guiding lines which directed the choice of questions and of problems on tests of this type were three in number. All questions and problems were designed to show important individual differences. First, bright children have a finer sense of understanding of language. They understand more readily and can follow instructions more easily. Second, in the execution of given tasks or in trying to do what they intend to do, the more intelligent children show more resourcefulness, greater ingenuity, more flexibility, and appropriate persistence than do duller children. Lastly, and perhaps the most important characteristic to be reflected in a scale of intelligence was that of self-evaluation or auto-criticism as Binet called it. This means exercising judgment and discretion in evaluating the answers one gives to questions requiring mental work. These three characteristics then serve to

define intelligence or general mental ability as Binet understood it. An intelligent child is then by definition one who readily understands and who can direct himself to assigned tasks and will discover effective means of overcoming difficulties met along the way and be able to judge whether he has done the job well or failed in the process.

The questions and problems Binet used in 1905 had another important characteristic. They could be arranged in order of difficulty and also corresponded to increases in the children's chronological ages as well. Problems that most six year old children could pass were placed at the six year level. Others that seven year olds could answer satisfactorily were placed at age 7 etc. Further, these 7 year questions could not be answered by any but a few children below that age. Older children however could pass them easily. In other words, as children grow older, they can answer more and more questions and accordingly obtain higher scores or a greater I.Q. The series of problems were so organized that at any age level, few children below that age could solve them and most children above that age could do them effectively. Accordingly, a clear relationship was established between increasing age and higher scores on the scale. It is this relationship which identifies the Binet Test as an age scale.

So far then, I have described various types of tests, their significance in human affairs, have talked about some of the men involved in their development, the key ideas which guided the construction of the first general mental tests, their purpose and something of their organization.

Now, let's see what happened after 1905. The first tests proved unsatisfactory in some ways and so were revised in 1908 and again in 1911. The chief change here was in relocating some of the items based on wider experience with larger numbers of children. The broader base of experience showed that some year tests were too easy, some too hard. In 1911, the test was translated into English and adapted for use in America where it has since become widely known and used. Successive revisions by Lewis M. Terman in 1916, 1937 and 1960 made it an increasingly effective tool for psychology and reflected the increasing sophistication gained through both experience and technical developments in the field of statistics.

In order to round out this brief over-view of tests of general mental ability, I'd like to mention next, the impact of World Wars I and II. More than anything else, the extensive use of intelligence tests in the ARMY showed their practical usefulness and their limitations. The balance however was in favor of further refinement of the tool. Many hundreds of psychologists trained in tests and testing contributed to this refinement. As an aside, it might be worth noting that periods of crisis, such as a war, are often the times when innovations and improvements are introduced and served to effect lasting changes in the traditional ways of doing things. What then were the improvements effected on the earlier forms of the Binet Test? There were five principal ones:

(a) A new conception of standardization of tests. A standardized test today is defined as one in which all conditions influencing performance are so controlled that the same people taking the test at

different times come up with the same general results.

(b) Objective measures of difficulty are now insisted upon. This makes the difficulty of the test independent of the judgment of the examiner and gives all persons taking the test a fairer chance to show their ability.

(c) Norms and their relevance to tests are better understood. Norms are the performance of the people on whom the test was standardized. The need for careful definition of the samples of persons who make up a standardization group is now clearer. Representative samples are to be preferred whenever possible.

(d) The consistency of scores on the constancy of the I.Q. is better understood. While scores do vary, it is now known, for example, that what a child earns on such a test at age 10 is very close to what he shall earn at age 35.

(e) Finally, the most important characteristic of all is that of validity. Does the general mental test measure what it is suppose to measure? An impressive array of over 300 research papers and some 50 years of accumulated experience permit a positive answer. Yes--- the test of general mental ability yields both useful and significant information within fairly well defined limits. Terman wrote some years ago, "The most significant single bit of information one can know about a child is his I.Q." It permits us to say today, "This child can or cannot learn!" One useful prediction that can be made with reasonable accuracy from knowledge of a child's score on a general mental test

would be:

If a child earns a score of 135 on the Stanford-Binet and if this child progresses through high school and enters college, he is likely to graduate and very likely with honors.

An area of interesting new research today is seeking to answer the question of what more needs to be known about successful achievement and especially about identifying those who can be creative. And so the cycle begins again. Having pretty well exploited the possibilities of one type of test and having defined its limitations, effort now turns to pressing needs unmet by current tools.

TESTING

1. Most American children are familiar with two kinds of tests. Identify these.
2. What do the popular IQ tests really measure?
3. Tests measuring progress in such school areas as history or social studies are identified by what name?
4. Identify four large scale users of tests.
5. What type of test has been said to be the outstanding success of scientific measurement of individual differences?
6. Identify three men who have influenced the development of tests.
7. The first successful mental test was designed for what purpose?
8. Identify the three characteristics of the behavior of bright children which served to guide the construction of the first successful mental test.
9. What is meant by a test called an age scale?
10. The first mental test invented was found somewhat unsatisfactory upon later experience. When was it revised?

11. What change was made to the first mental test in the early revisions?

12. What were the two outcomes on the testing movement attributable to World Wars I and II?

13. What social effect is associated with times of crises?

14. How is standardization defined with reference to tests?

15. What are norms?

16. Which kind of sample is to be preferred whenever possible?

17. Are IQ's constant?

18. Which is the most important single characteristic of a test?

19. The most significant single bit of information one can know about a child is his IQ. Whose quotation is this? Identify by name only.

20. What question is uppermost in the research on mental tests at the present time?

LEARNING

The purpose of this lecture is to explain some of the basic concepts in what is called stimulus-response learning theory as distinct from the cognitive theory of learning. As its name suggests, stimulus-response theory tries to describe learning as the establishment of specific relationships between stimulus events and consequent responses. For our purposes we shall define learning as an enduring change in behavior as a result of training or experience. The terms "training" and "experience" are intended to cover a wide range of learning situations. Learned changes in behavior should be distinguished from those changes which are attributable to other factors. One can distinguish three factors which cause "unlearned" changes in behavior, (1) a change in motivation, such as becoming hungry, (2) the taking of a drug such as alcohol may result in a non-learned change in behavior, for it is temporary and does not involve prior training or experience, and (3) fatigue states also can result in non-learned changes in behavior.

Actually, of course, learning is a process which must be inferred. It cannot be observed. Only performance can be directly observed, not learning. The concept of learning is an example of a <u>construct</u>, based on inferences from observed behavior.

Learned behavior will not occur unless the organism is motivated. For example, we might have learned how to type, but we won't do so unless we are appropriately motivated. In most versions of learning theory the terms need motive, and drive are used interchangeably to refer to factors which energize and direct behavior.

Most learning theories distinguish between two types of learning arrangements. One is classical conditioning, which is exemplified by the well-known experiments of Pavlov in training a dog to salivate at the sound of a tone when this tone had paired with food reward a number of

times. A second kind of learning arrangement is called instrumental or operant conditioning. The Skinner box, which consists of a box with a bar and a food or water delivery mechanism, is frequently used in studies of instrumental or operant conditioning in rats. There are two main differences between classical and instrumental conditioning. The first is that in classical conditioning there is a known stimulus which at the outset of training dependably elicits the response to be learned. For example, the food stimulus dependably elicits salivation in Pavlov's experiment. In conditioning a rat to press a bar in a Skinner box we do not know the specific stimulus which causes this response. The second difference is that in classical conditioning the stimulus (e.g., food) for bringing about learning precedes the response, whereas the instrumental conditioning this stimulus follows the response. In the Skinner box situation, for example, food follows barpressing. The name for the response-strengthening effect of a stimulus is reinforcement, and the stimulus which has this effect is known as a reinforcer.

The most widely held theory of reinforcement is known as the drive-reduction theory. This theory holds that a stimulus is reinforcing if it results in the reduction of a drive; for example, food is reinforcing because it reduces the hunger drive. While there is much evidence in support of this theory of reinforcement, it has been strongly challenged by the so-called latent learning experiments. Typically in a latent learning experiment an albino rat is given an opportunity to explore a situation, such as a maze, without any obvious drive-reduction being involved. His subsequent performance, however, reveals that he has learned something about the situation, for when he is made hungry he very quickly learns

how to get to the goal area with few or no entrances into blind alleys. Drive reduction theories have had to argue that some sort of drive (such as curiosity, anxiety, and the like) must have been present and reduced to some degree during the earlier training.

Some experiments by Sheffield and Roby, in which a non-nutritive substance like saccharine functioned as a reinforcer, are also instructive. A saccharine solution, which tastes sweet to human subjects, served to strengthen bar-pressing responses in rats when it followed such responses. Since the substance is non-nutritive, presumably there is no hunger drive reduction yet there was learning. A drive-reduction theorist would have to argue that saccharine had acquired a secondary reinforcing function. In order to explain this idea, it is necessary to distinguish primary from secondary reinforcers. A primary drive is an unlearned drive, one that is acquired as a result of a stimulus being paired with primary drive. A good example of a secondary drive is fear, which can be acquired by sounding a buzzer and turning on an electric shock, which in turn arouses pain and fear.

LEARNING

Learning is defined as a (1)_____ in behavior as a result of (2)_____ or (3)_____.

The three factors which have been mentioned as causing unlearned changes in behavior are (4)_____, (5)_____ and (6)_____.

Learning itself is not observable, it must be inferred from (7)_____. Learned behavior does not occur unless the organism is (8)_____.

In most versions of learning theory, the terms "need," (9)_____ and (10)_____ are used interchangably.

Learning to salivate when a tone sounds is an instance of (11)_____ conditioning, whereas learning to press a bar for food reward exemplifies (12)_____ conditioning.

In classical conditioning we always have a (13)_____ stimulus and the stimulus always (14)_____ the response.

The name for the response-strengthening effect of a stimulus is (15)_____.

The most widely held, although controversial, theory of reinforcement is the (16)_____ theory. The experiments which have been most difficult for this theory to handle are the (17)_____ experiments.

The saccharine solution experiment was done to show that learning could occur in the absence of (18)_____ .

The opposing theorist argued that saccharine solution itself had acquired a (19)_____ function.

A learned drive is called a (20)_____ drive, whereas an unlearned drive is called a (21)_____ drive.

Whereas pain is an example of a (22)_____ drive, fear in response to a signal is an example of a (23)_____.

APPENDIX II

Latin Square Design Paradigm

Groups:	I	II	III	IV	V
Lecture Material:	1	2	3	4	5
Leaders:	A	B	C	D	E

Groups:	I	II	III	IV	V
	A_1	B_2	C_3	D_4	E_5
	B_3	C_4	D_5	E_1	A_2
	C_5	D_1	E_2	A_3	B_4
	D_2	E_3	A_4	B_5	C_1
	E_4	A_5	B_1	C_2	D_3

APPENDIX III

Inspiration, Resistance and Heart Rate means and Variability in Terms of Position

Inspiration $\bar{X}$

	1st	2nd	3rd	4th	5th
1	32.4	34.3	23.1	34.9	35.7
2	32.2	30.5	29.3	34.2	29.4
3	28.9	32.3	29.4	31.3	30.7
4	32.0	35.4	34.9	31.8	28.2
5	32.2	35.9	36.5	36.4	37.7
Σ	157.7	168.4	153.2	168.6	161.7
$\bar{X}$	31.5	33.7	30.6	33.7	32.3

Inspiration 6^2

	1st	2nd	3rd	4th	5th
1	31.6	63.0	36.1	45.1	38.1
2	72.3	140.0	86.0	57.4	94.7
3	46.1	75.2	52.8	64.7	44.3
4	48.0	36.4	39.7	40.4	32.3
5	97.7	61.2	51.9	66.9	48.5
Σ	295.0	375.8	266.5	272.5	257.9
$\bar{X}$	59.0	75.2	53.3	54.5	51.6

Heart Rate $\bar{X}$

	1st	2nd	3rd	4th	5th
1	13.2	12.2	12.4	11.9	12.8
2	13.3	14.0	14.2	14.8	13.3
3	12.8	12.6	13.4	13.7	13.4
4	12.7	14.2	13.3	13.0	13.0
5	12.6	13.1	13.5	13.4	13.4
Σ	64.6	66.1	66.8	66.8	65.9
$\bar{X}$	12.9	13.2	13.4	13.4	13.2

Heart Rate 6^2

	1st	2nd	3rd	4th	5th
1	.12	.39	.71	.42	.76
2	.68	.93	.42	1.02	.45
3	1.28	.61	.69	.75	.52
4	.42	.94	.92	.57	.76
5	.76	1.08	.90	1.58	.56
Σ	3.86	3.95	3.64	4.34	3.05
$\bar{X}$	.77	.79	.73	.87	.61

$\bar{X}$ Minimal Resistance for all Groups

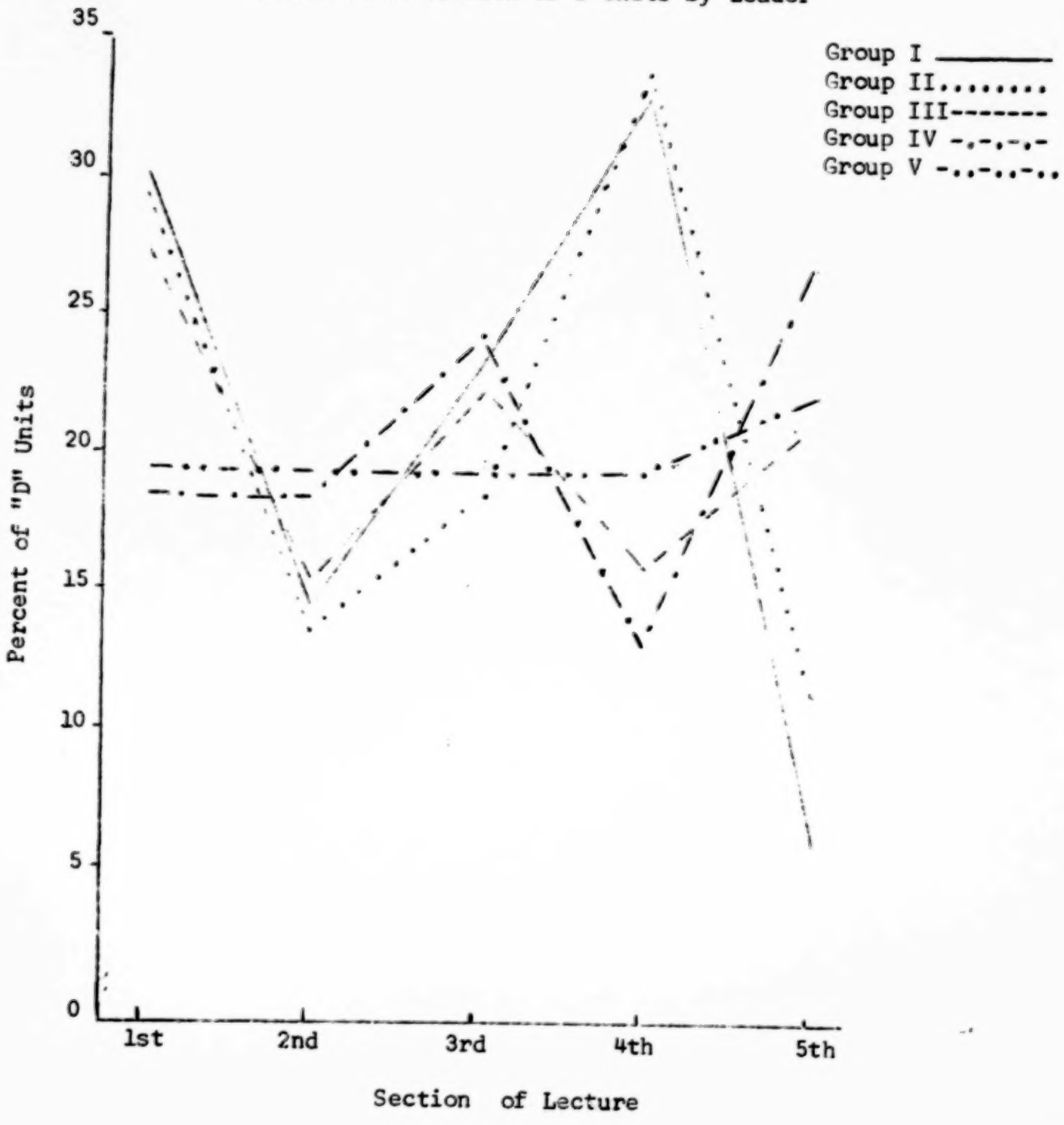
	1st	2nd	3rd	4th	5th
1	51,259	46,950	47,450	45,892	39,377
2	65,561	54,585	46,171	38,221	49,264
3	59,025	60,133	47,573	46,215	39,180
4	79,469	117,069	42,120	96,838	47,450
5	69,561	57,517	57,832	35,620	40,332
Σ	324,876	336,254	241,146	262,786	215,603
$\bar{X}$	64,975	67,251	48,229	52,557	43,122

6^2 Resistance

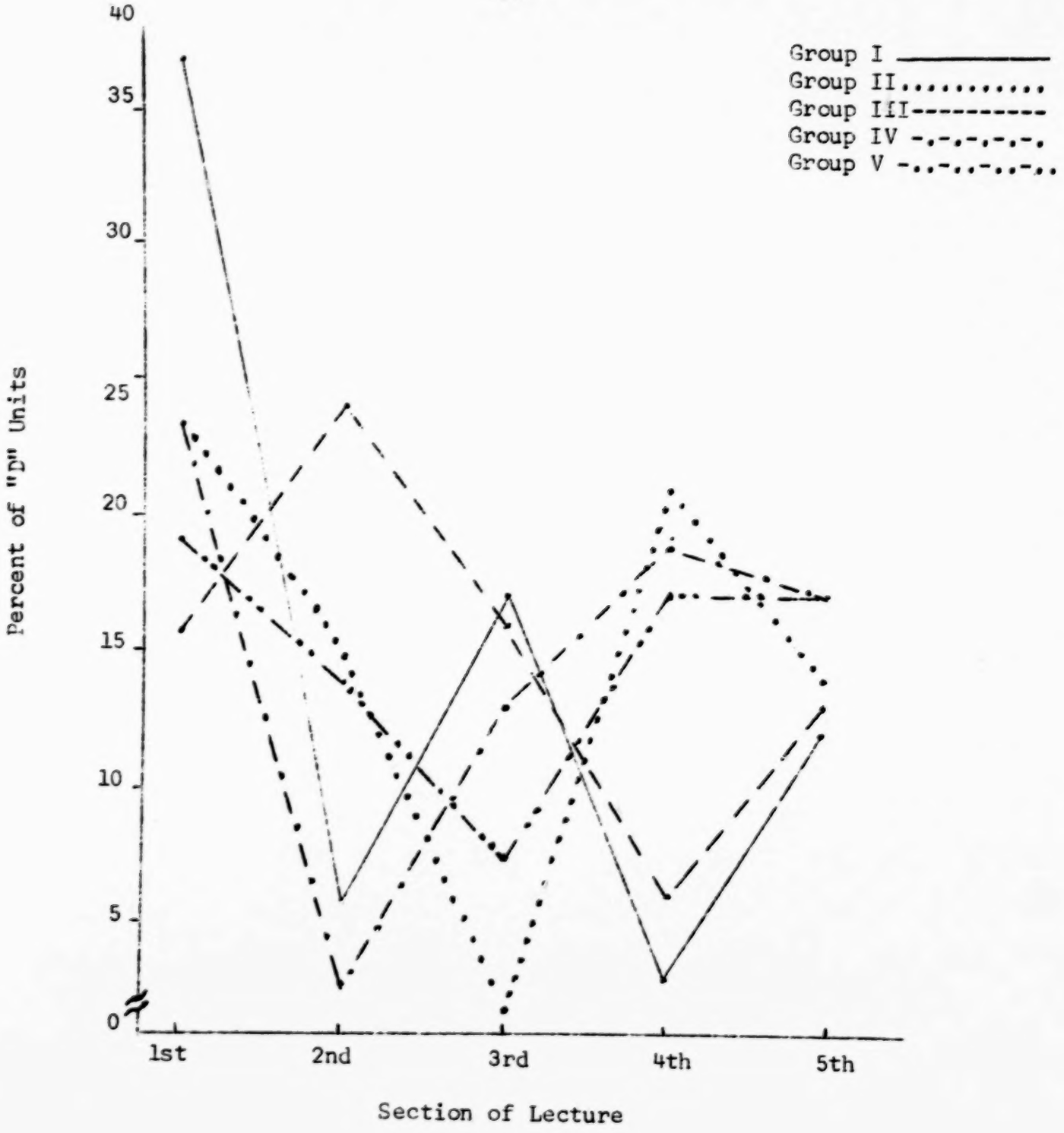
	1st	2nd	3rd	4th	5th
1	53,187,279	28,236,411	86,845,204	18,449,864	14,307,752
2	66,387,705	130,202,739	11,203,286	681,895,846	11,304,590
3	51,420,309	65,876,162	51,420,309	1,591,363,761	33,386,079
4	62,178,297	105,051,933	45,536,277	387,648,402	9,171,983
5	58,088,232	39,086,725	109,452,739	25,190,995	19,906,720
Σ	291,261,882	368,454,000	304,457,815	2,707,548,868	88,077,124
$\bar{X}$	58,252,376	73,690,800	60,891,563	541,509,773	17,615,425

APPENDIX IV

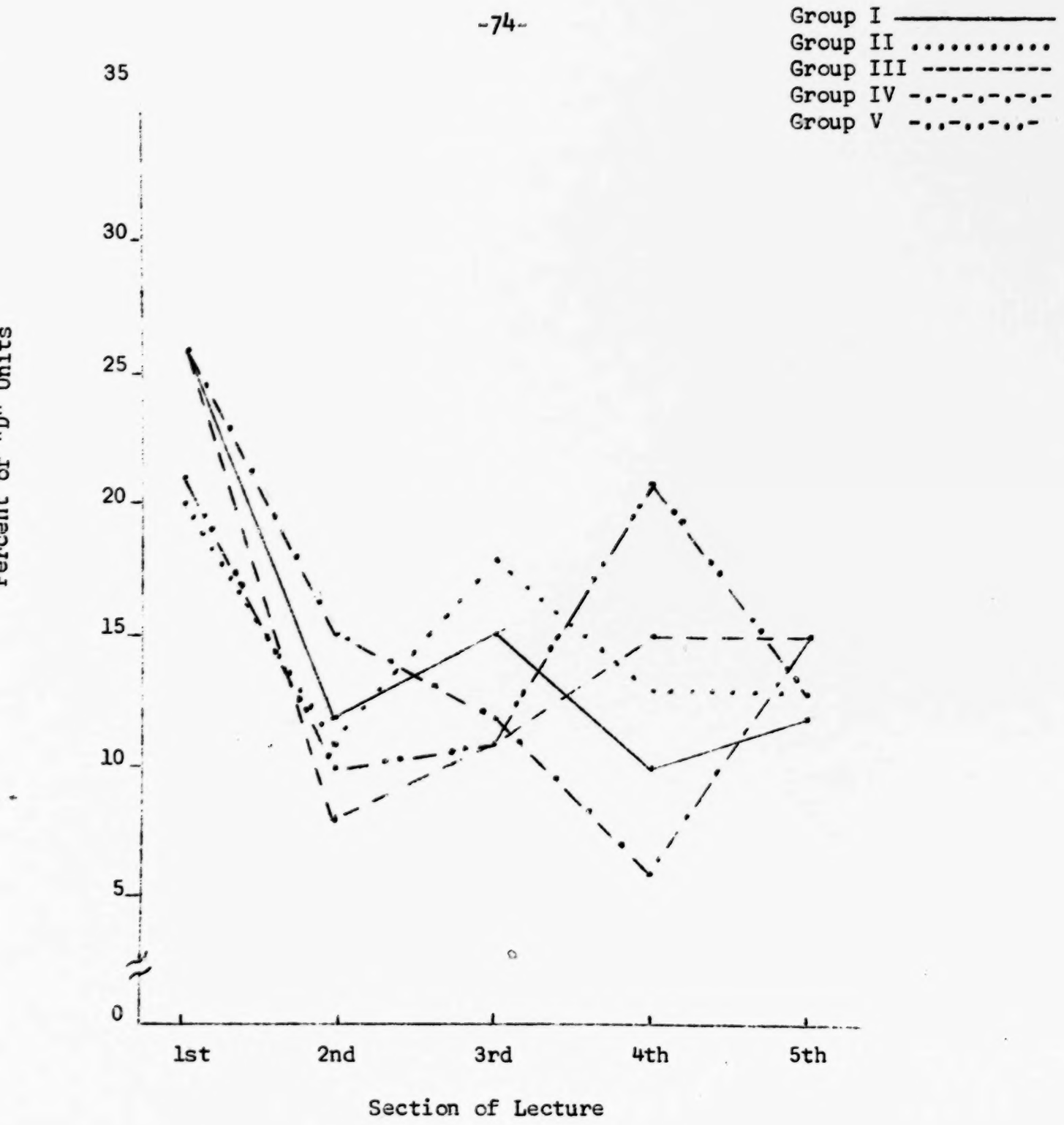
Visual Presentation of D Units by Leader



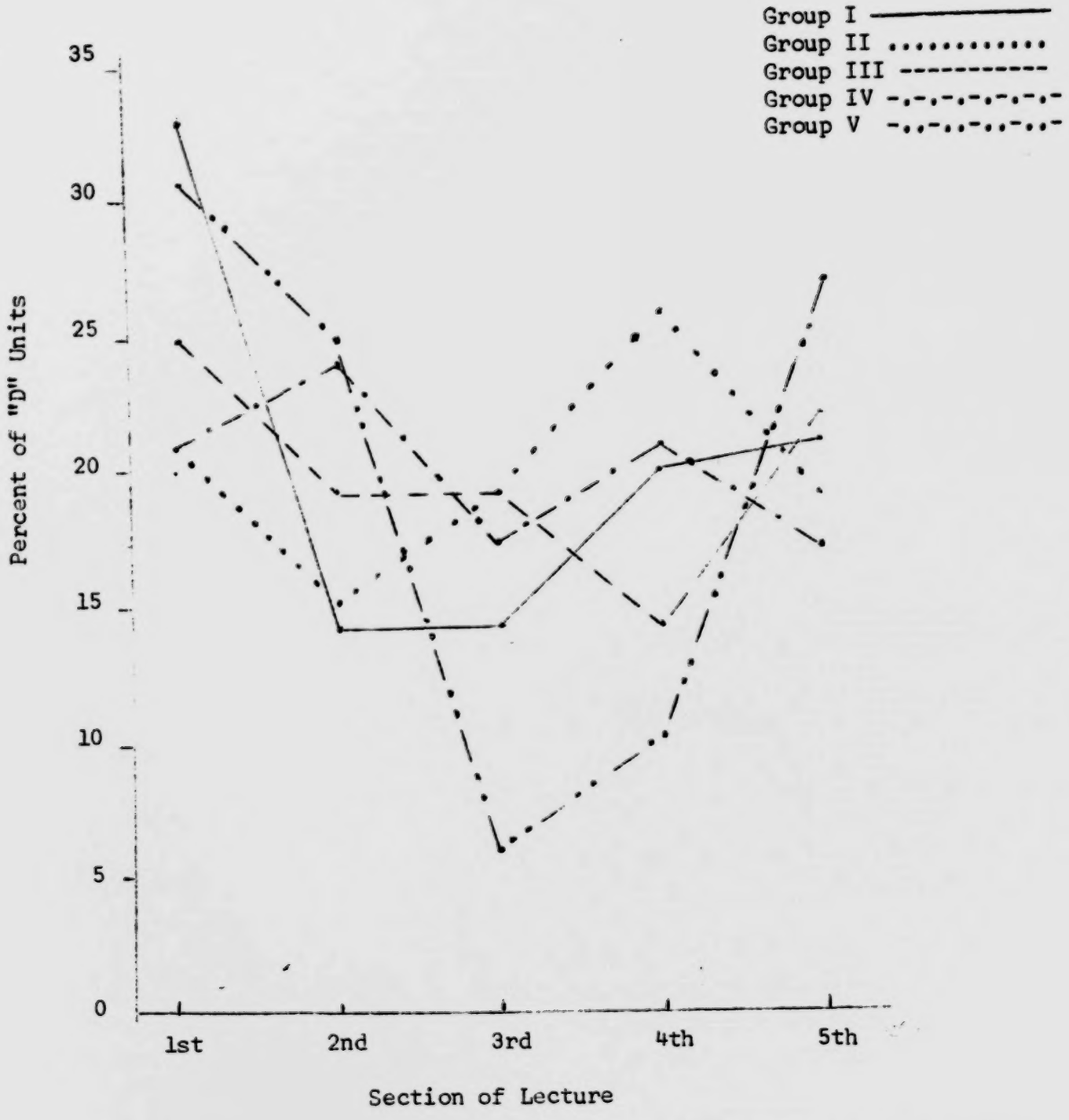
Percent of total "D" units in each of five equal sections of the lectures delivered by Lecturer A to five groups.



Percent of total "D" units in each of five equal sections of the lectures delivered by Lecturer B to five groups.

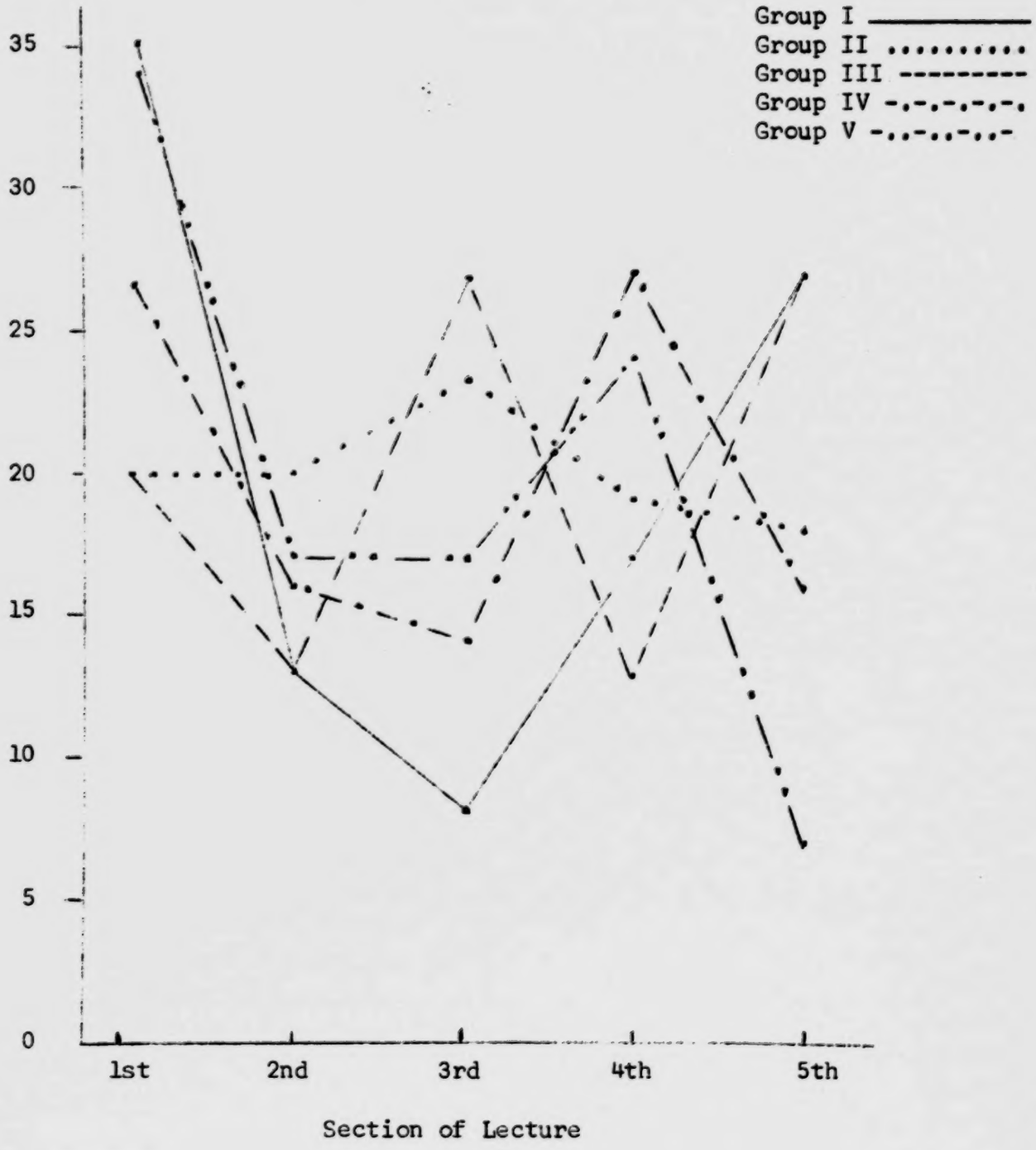


Percent of total "D" units in each of five equal sections of the lectures delivered by Lecturer C to five groups.



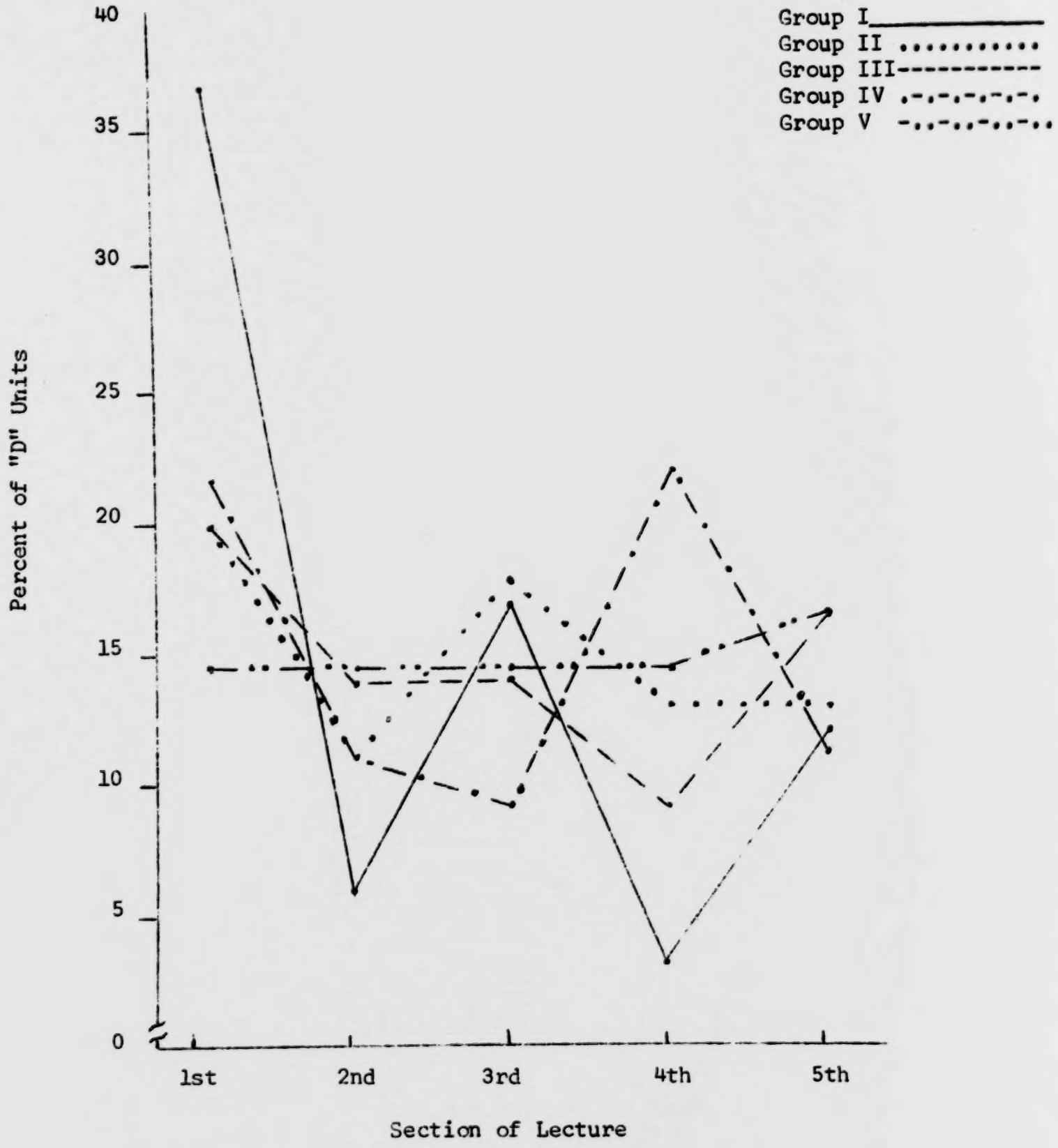
Percent of the total "D" units in each of five equal sections of the lectures delivered by Lecturer D to five groups.

Percent of "D" Units

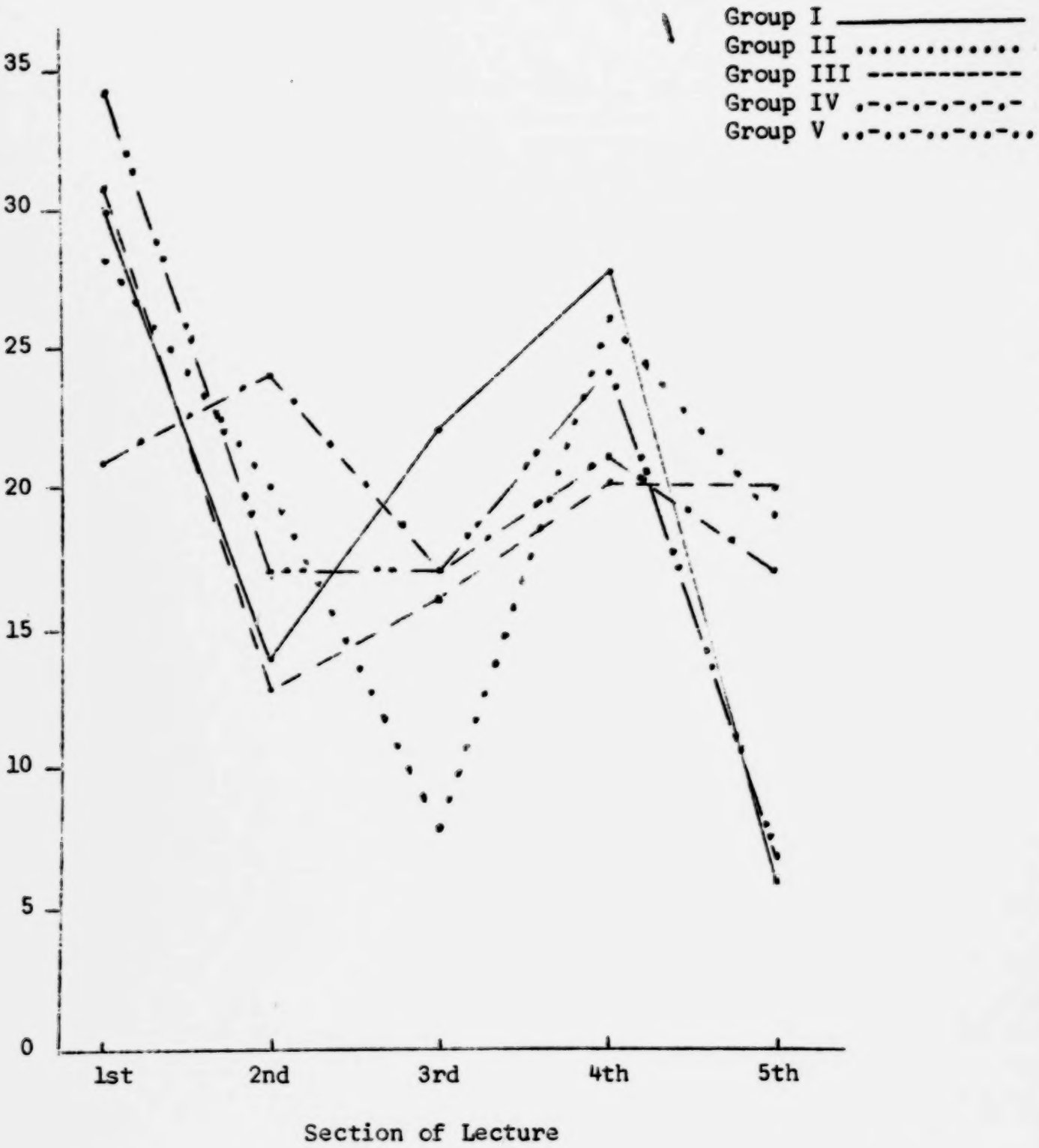


Percent of total "D" units in each of five equal sections of the lectures delivered by Lecturer E to five groups.

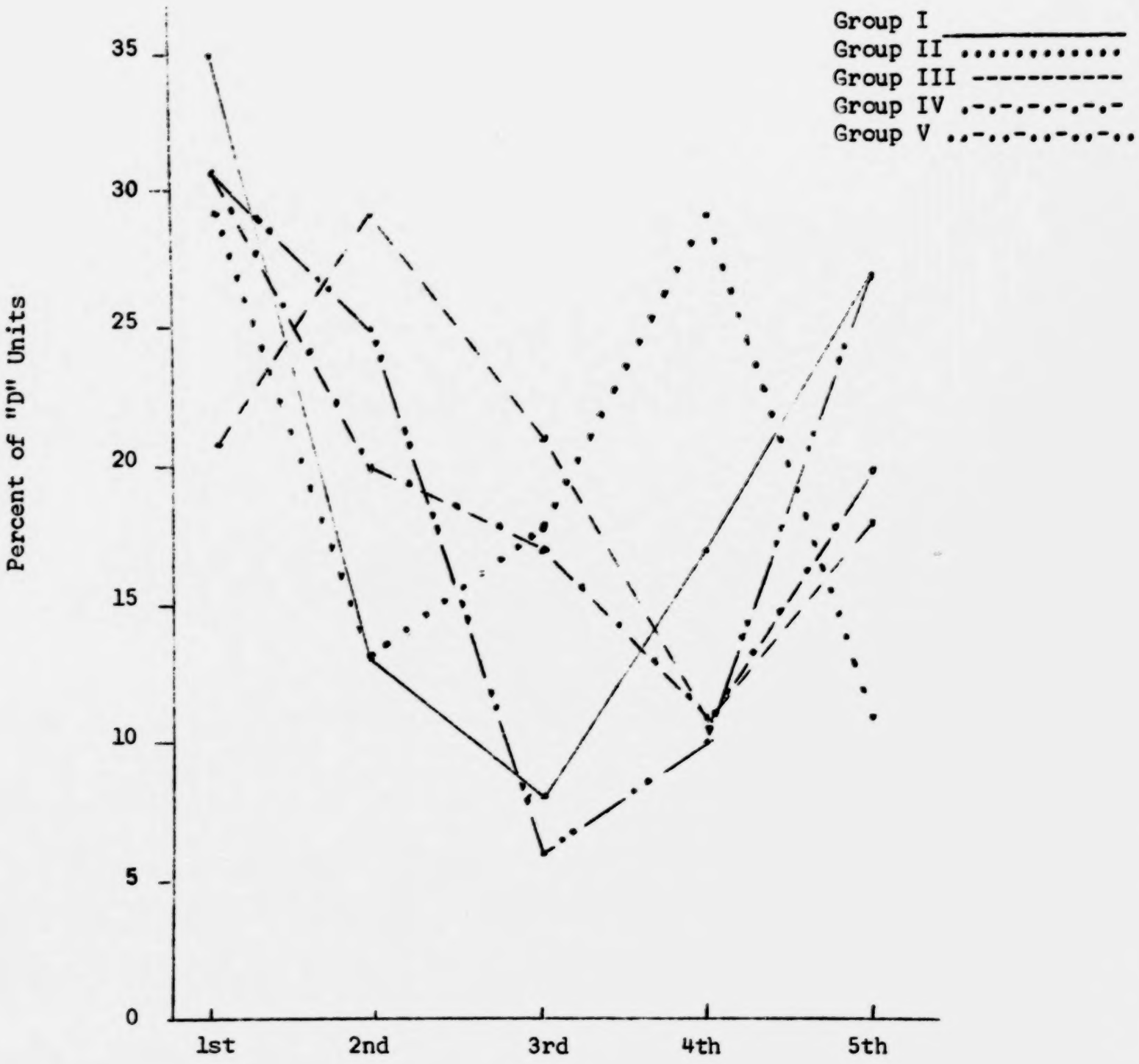
Visual Presentation of D Units by Groups



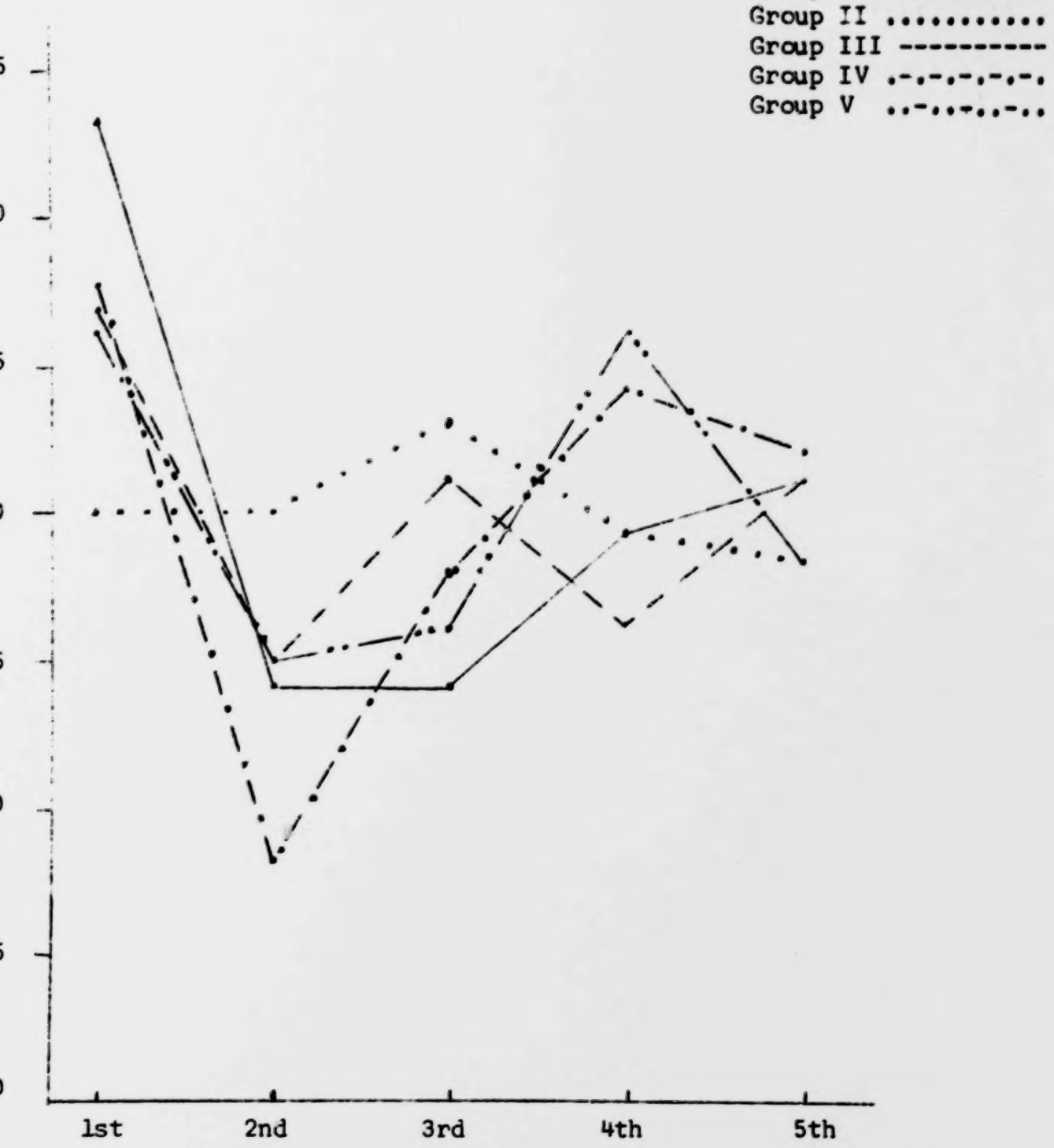
Percent of total "D" units in each of five equal sections of the ear lecture for five groups.



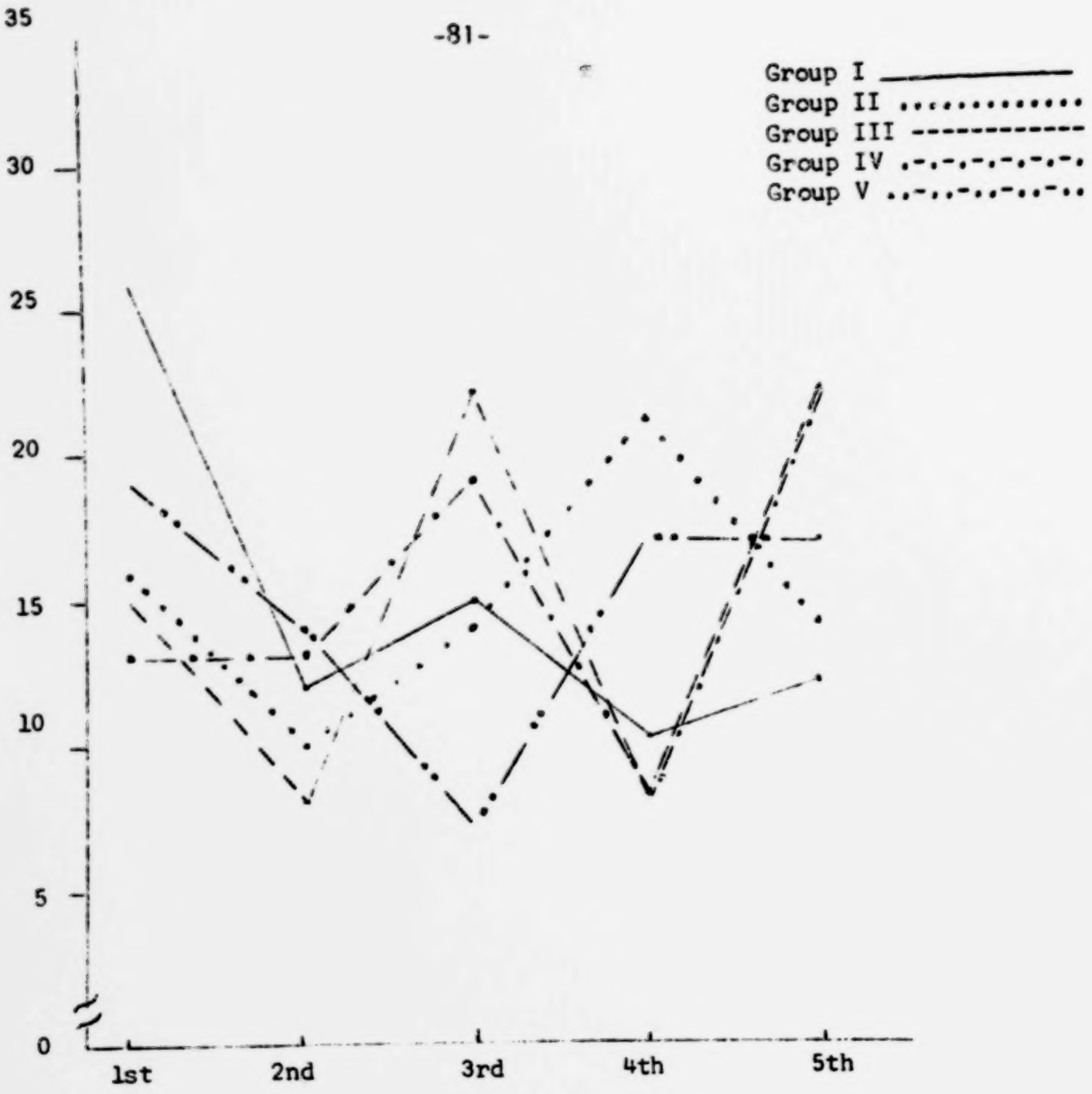
Percent of total "D" units in each of five equal sections of the learning lecture for five groups.



Percent of total "D" units in each of five equal sections of the history lecture for five groups.

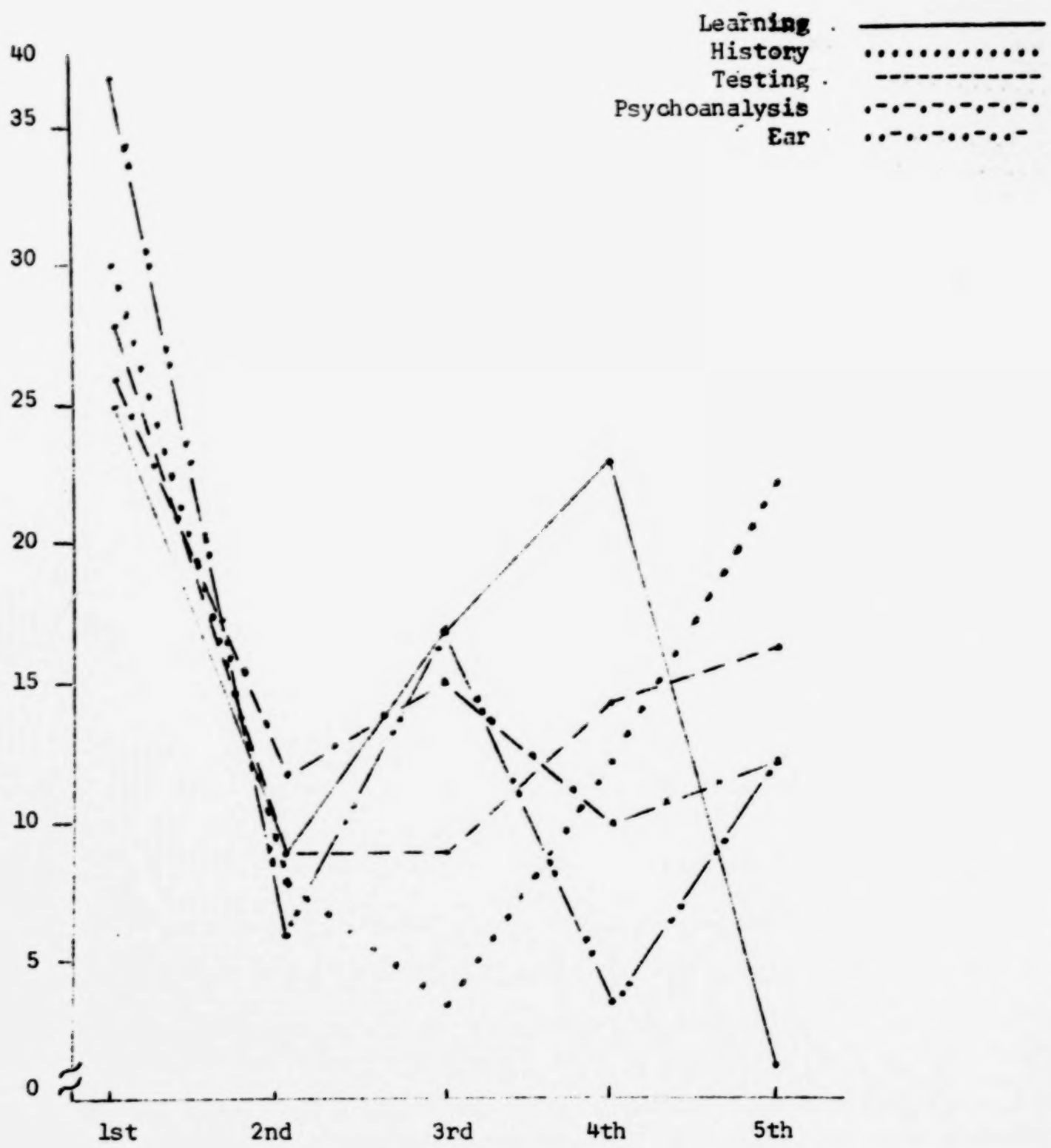


Percent of total "D" units in each of five equal sections of the testing lecture for five groups.

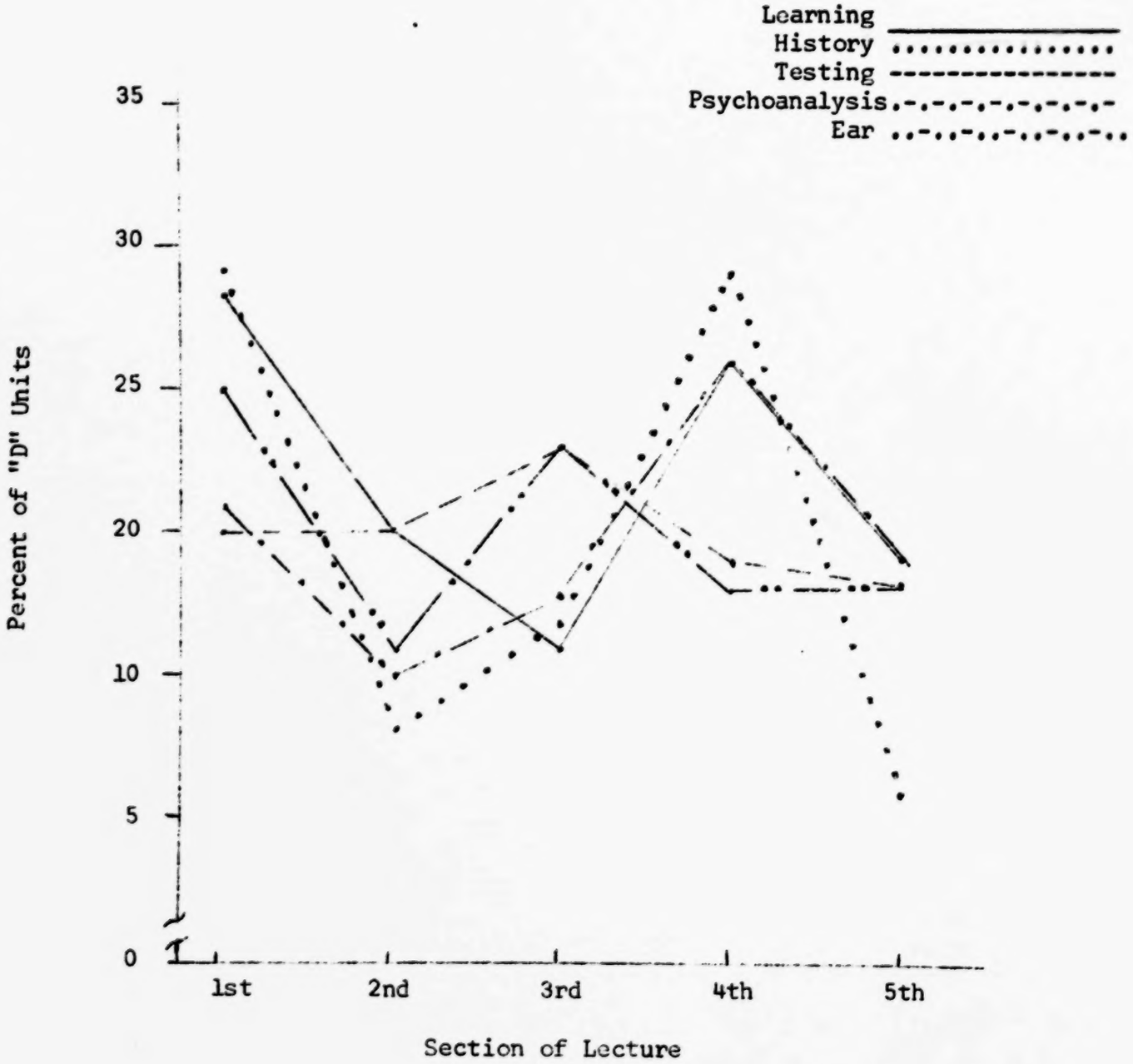


Percent of total "D" units in each of five equal sections of the psychoanalysis lecture for five groups.

Visual Presentation of D Units by Lecture

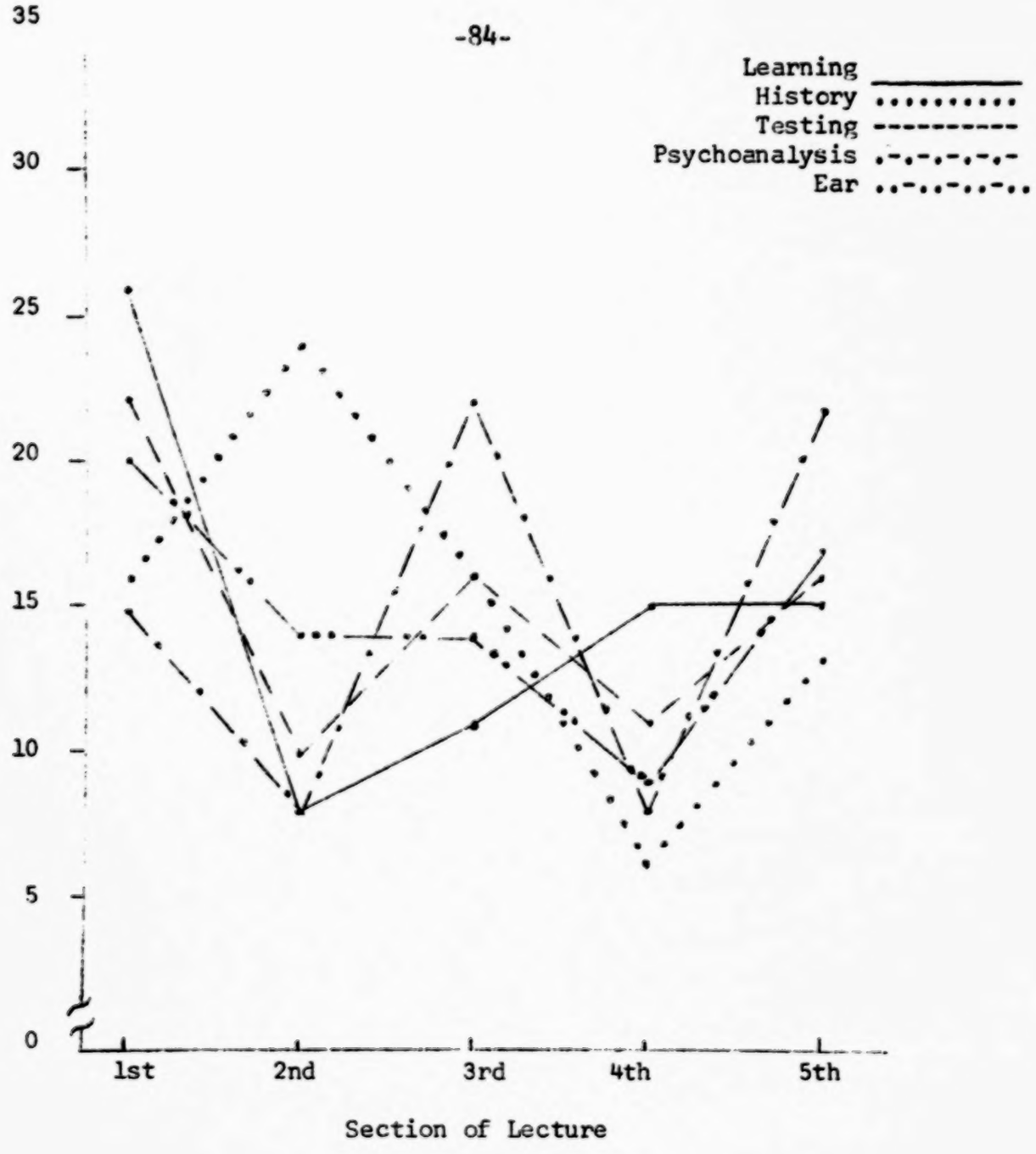


Percent of total "D" units in each of five equal sections of the five lectures delivered to Group I.

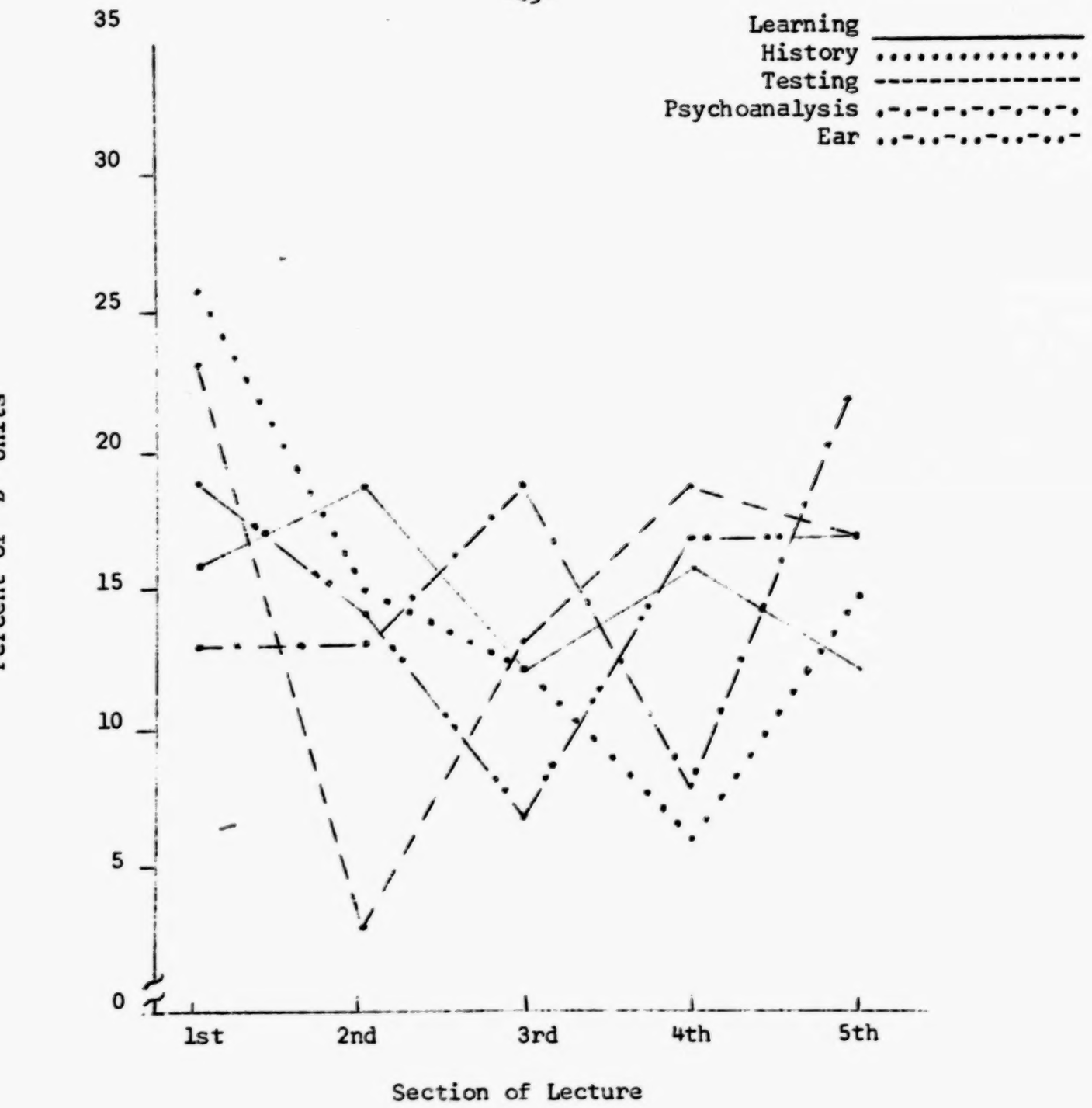


Percent of total "D" units in each of five equal sections of the five lectures delivered to Group II.

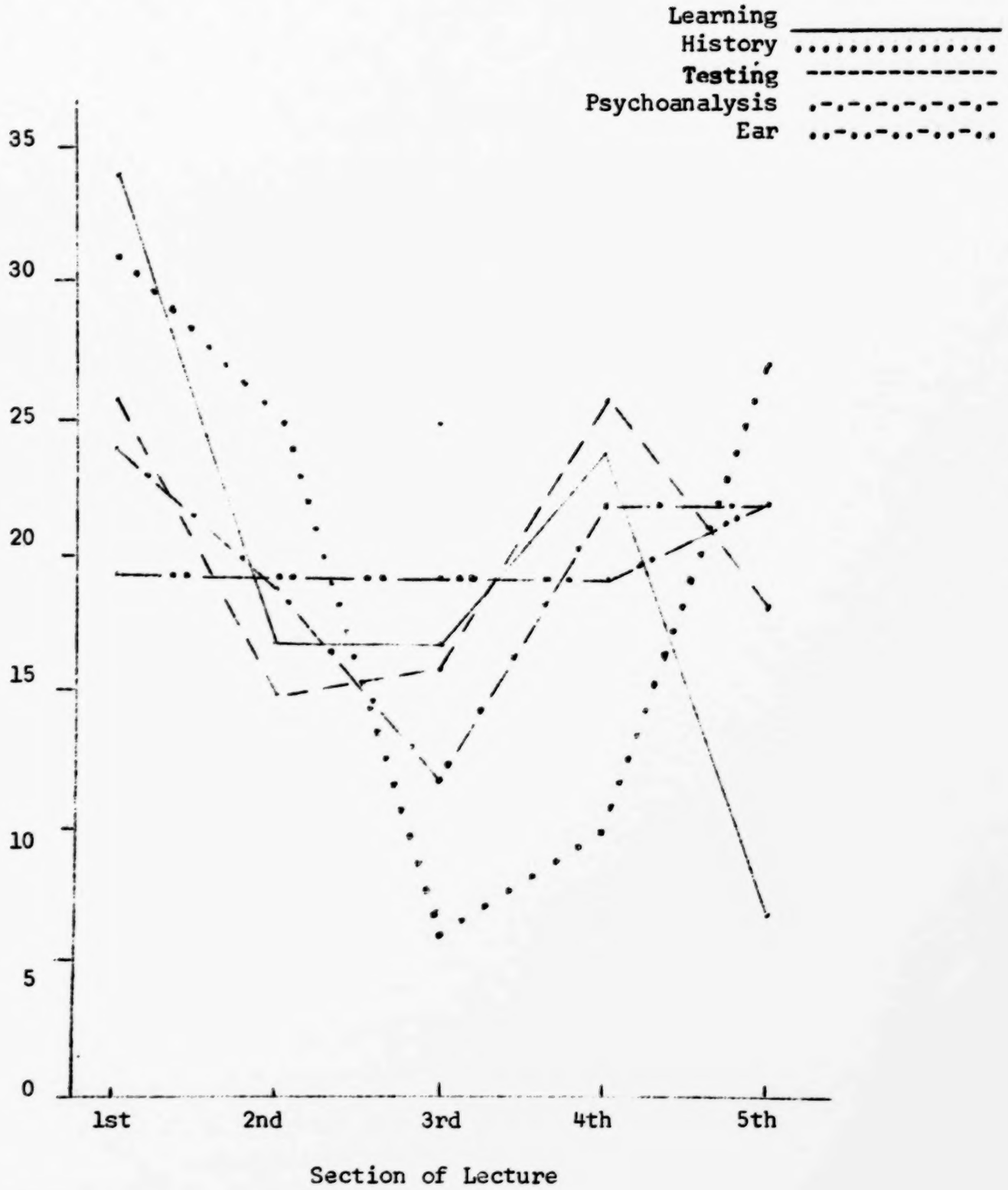
Percent of "D" Units



Percent of total "D" units in each of five equal sections of the five lectures delivered to Group III.



Percent of total "D" units in each of five equal sections of the five lectures delivered to Group IV.



Percent of total "D" units in each of five equal sections of the five lectures delivered to Group V.

APPENDIX V

Time for Each Lecture and Leader

	Learn	Psychcanalysis	Test	History	Ear	Σ	$\bar{X}$
Wasden (1)	5'27"	6'50"	9'37"	6'47"	6'42"	35'23"	7'4.6"
Bruce (3)	5'35"	7'20"	9'30"	7'10"	7'19"	36'54"	7'22.8"
Boutin (4)	5'25"	8'16"	9'52"	7'13"	7'40"	38'26"	7'41.2"
Steve (5)	6'02"	8'35"	10'52"	7'03"	7'57"	40'29"	8'05.8"
Don M. (2)	6'30"	8'50"	10'53"	7'39"	8'23"	42'15"	8'27"
Σ	28'59"	39'51"	50'44"	35'52"	38'01"		
$\bar{X}$	5'47.8"	7'58.2"	10'08.8"	7'10.4"	7'36.2"		

APPENDIX VI

Psychological Reports, 1962, 11,800 Southern Universities Press 1962

PRELIMINARY REPORTS ON SOME EXPERIMENTS WITH POLYGRAPHS

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University of Utah

For the last year we have been working in a laboratory which houses seven polygraphs. We are trying to assess with some measures (GSR determinants, respiration ratios, and heart rate) whether autonomic reactivity is informative about interaction among group members and also whether it is related to attention and learning in groups.[1] Specifically, we wondered if high reactivity in a lecturer is related to the reactivity of his group members and whether such reactivity will enhance learning.

We are also engaged in five other studies: (1) reliability of GSR measures over time; (2) adaptation patterns to repeatedly introduced stimuli of normal and maladjusted children (a word list repeated 10 times); (3) a psychophysical measure of the "aha" experience (during a concept formation test); (4) psychophysical measures as related to changes in judgment (like or dislike of human photographs; (5) the effect of artificially triggered psychophysical reaction states on learning (nonsense syllables introduced at conduction increase).

Presently, our greatest excitement comes from the analysis of the adaptation patterns. We investigated psychophysical adaptation patterns to the introduction of repeated stimuli. The three measurements we became interested in were the distance between stimulus introduction

and verbal response, stimulus introduction and GSR response, verbal response and GSR response. There appear to be some differences with these measures in adaptation rate to repeated stimuli (emotional vs. neutral words). We also have reason to believe that, if S gives the same response to a given stimulus, he behaves psychophysically very differently from an S who gives a novel response to the same stimulus. While typically, for S who gives a novel response to a stimulus, the GSR precedes the verbal response; with redundant responses, his verbal response is more likely to precede the GSR, at least after 5 to 8 redundancies. Also, the interesting observation was made, that if one divides Ss into slow and fast responders, the fast responders typically show more redundancy in response to a given stimulus. Speed is apparently bought at the cost of novelty.

Finally, a point that may be of significance: those who want to score inspiration-expiration data accurately should note that the standard paper has vertical lines while the pen throws an arc, which encourages errors.

Accepted November 5, 1962.

[1]Supported by Grant 1308, U.S. Office of Education.